CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

APPENDICES

MAY 2003

MARICOPA
ASSOCIATION of
GOVERNMENTS

APPENDIX TO THE CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

Prepared by:

MARICOPA ASSOCIATION of GOVERNMENTS

May 2003

Technical Assistance Provided By:

Arizona Department of Environmental Quality
Arizona Department of Transportation
Maricopa County Environmental Services Department
U.S. Environmental Protection Agency

CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

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Exhibit I: 1999 Periodic Carbon Monoxide Emission Inventory for the Maricopa County, Arizona Nonattainment Area. Maricopa County Environmental Services Department. November 2001, Revised August 2002.

Exhibit 2: Technical Support Document for Carbon Monoxide Modeling in Support of the Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. April 2003.

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APPENDIX A

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EXHIBIT 1

1999 Periodic Carbon Monoxide Emission Inventory for the Maricopa County, Arizona Nonattainment Area. Maricopa County Environmental Services Department. November 2001, Revised August 2002**.**

1999 Periodic
Carbon Monoxide Emission Inventory

for the

Maricopa County, Arizona Nonattainment Area

November 2001
Revised August 2002

Prepared and submitted by:

Maricopa County Environmental Services Department
Air Quality Division
1001 North Central Avenue, Suite 695
Phoenix, Arizona 85004

1999 Periodic Carbon Monoxide Emission Inventory
for Maricopa County, Arizona

Errata

Nonroad Equipment Emissions (Chapter 4)

A recent review of the calculations used to develop 1999 emissions estimates for nonroad mobile sources indicated that a number of correction factors were inadvertently applied when "growing" the emissions estimates based on earlier 1996 calculations. In addition, a few minor errors were found in the underlying 1996 data, which when corrected, also affected the 1999 emissions values for 2- and 4-stroke gasoline equipment and diesel equipment. Corrections made to the 1999 calculations are described below. Revisions made to the 1996 data are more fully described in the errata for the 1996 emissions inventory.

- Two correction factors used to develop the 1996 nonroad emission inventory was incorrectly re-applied when developing the 1999 emission inventory. This "NEVES A/B inventory ratio" and a 50% increase in VOC emissions to account for running and resting losses from lawn and garden equipment were removed from the revised 1999 calculations.
- A 2.4% reduction in the projected growth rate of lawn and garden equipment had been applied in 1996 to account for the Phoenix municipal xeriscape ordinance. Since no further reductions are expected, this correction factor was removed from the 1999 calculations.

Taking the above changes into account, the following table summarizes the differences in 1999 annual and daily nonroad engine CO emissions.

	Annual CO (tpy)	**Daily CO (tpd)**
Original Calculations	148,013.5	350.66
Revised Calculations	175,893.8	406.46
Difference	+27,880.3	+55.80

To ensure consistency among chapters, the above corrections have already been incorporated into the August 2002 version of the inventory, and are reflected in the tables and graphics in the Executive Summary and Chapters 1 and 4.

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EXECUTIVE SUMMARY

This carbon monoxide (CO) inventory was developed based on requirements in the Clean Air Act Amendments of 1990 (CAAA), passed by Congress and signed into law by the President in November 1990. Title I of the CAAA contains provisions on the required development of carbon monoxide emission inventories for designated areas that failed to meet the National Ambient Air Quality Standards (NAAQS) for carbon monoxide. Maricopa County was designated a CO nonattainment area on November 15, 1990, and was reclassified as serious effective August 28, 1996. Maricopa County Environmental Services Department (MCESD) prepared this 1999 periodic CO emission inventory to meet the requirements of Title I of the CAAA.

This inventory provides calculations of both annual and average season day CO emissions for 1999. The average season day CO emissions mainly cover the period from November 1998 through January 1999. The sources of emissions are categorized in four areas: 1) point sources; 2) area sources; 3) nonroad mobile sources and 4) onroad mobile sources.

A total of 41 individual point sources are identified in this CO inventory. These point sources include a) those sources that emit 50 tons[1] or more per year of CO, b) those sources that were listed as a point source in the 1990, 1993, 1996 CO emission inventories, c) those sources that were listed as point sources in the ozone inventories, both past and present, and have CO emissions greater than 5 tons per year and d) those point sources that are the only source of CO in a category that would otherwise have been considered an area source. Individual stationary point sources account for 0.8 percent of the total average season day CO emissions or 9.09 tons. Stationary point sources contributed an estimated 1753 tons of CO in 1999.

Area sources are those stationary sources in the nonattainment area that are too small to be considered point sources but may be significant in numbers and emit significant amounts of CO. Stationary area sources account for approximately 2.1 percent of the total average season day CO emissions or 24.06 tons per day. Stationary area sources contributed 5,840 tons of CO in 1999.

Nonroad mobile sources include aircraft, locomotives, diesel equipment, 4-stroke gasoline equipment, and 2-stroke gasoline equipment in the nonattainment area. Nonroad mobile sources account for 50.0 percent of the total average season day CO emissions or 573.95 tons daily. Nonroad mobile sources contributed 195,042 tons of CO in 1999.

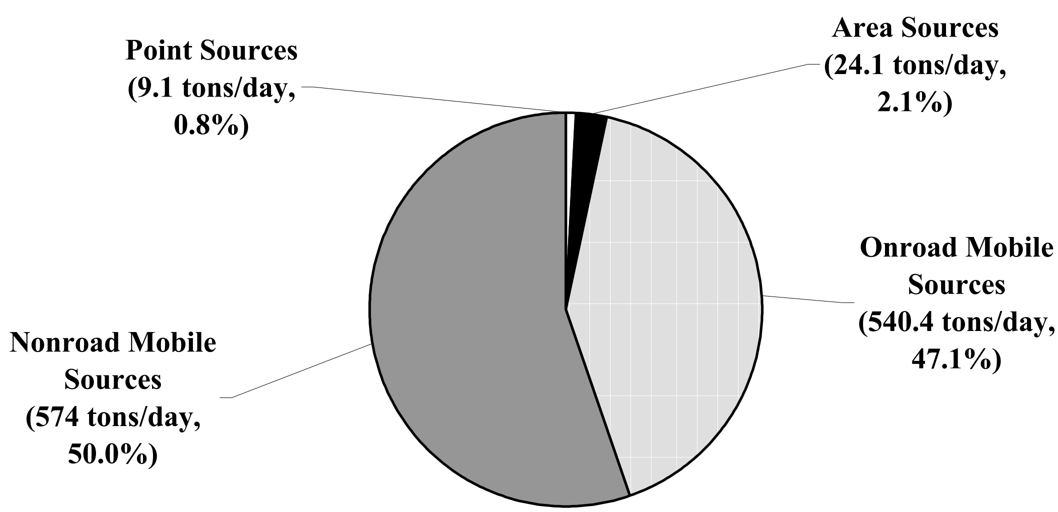
The Maricopa Association of Governments (MAG) calculated onroad mobile source emissions. Emission factors for seven vehicle type categories are calculated using MOBILE5a, the latest in a series of models approved by the EPA for the purposes of estimating motor vehicle emission factors for planning. Onroad mobile sources

[1] As the English system of measurement is used primarily in this document, the term "ton" refers to an English (or short) ton, equal to 2,000 pounds.

accounted for 47.1 percent of the total average season day CO emissions, or 540.41 tons per day. Onroad mobile source annual emissions were not calculated. A chart of this information can be seen with Figure ES–1.

This report is structured to include an overview of the inventory process, tables of summary data, data documentation, and quality assurance steps taken. Each section of the inventory is an independent discussion, which includes an introduction, scope, method and approach for estimating emissions, subsections with example calculations, and summary.

Figure ES-1. Source Category Contributions to Season Day CO Emissions
(Percentage of total season-day CO emissions)



SECTION 1. BACKGROUND AND EMISSIONS SUMMARY

1.1 Background

1.1.1 Type of Inventory, Pollutants, and Source Categories

This carbon monoxide (CO) inventory was developed based on federal requirements stated in the Clean Air Act Amendments of 1990 (CAAA), passed by Congress and signed into law by the President in November 1990. Title I of the CAAA contains provisions on the required development of ozone and carbon monoxide emission inventories for designated areas that failed to meet the National Ambient Air Quality Standards (NAAQS) for ozone and carbon monoxide. The Maricopa County CO nonattainment area was classified as moderate with a design value of 12.6 ppm, and has since been reclassified to serious. Consequently, Maricopa County Environmental Services Department (MCESD) prepared this 1999 periodic CO emissions inventory.

This inventory quantifies both annual and average season day CO emissions from stationary point, area, nonroad mobile, and onroad mobile emission sources for 1999. The season day CO emissions cover the period from November 1998 through January 1999 (MCESD, 2001).

1.1.2 Geographic Area

The Maricopa County CO nonattainment area is approximately 1,962 square miles, or approximately 20 percent of the total Maricopa County land area. The geographic boundaries of the nonattainment area are shown in Figure 1–1.

1.1.3 Demographic Profile

A demographic profile of the Maricopa County CO nonattainment area was provided by the Maricopa Association of Governments (MAG) and is included as Appendix 1–1. This demographic profile was derived from the MAG update of the population and socioeconomic database for Maricopa County (MAG, 2000).

The square miles within the nonattainment area boundary were calculated by digitizing the boundary and summing the area within the boundary using ArcInfo GIS software. There are 1,962 square miles within the CO nonattainment area boundary. Definitions of the terms and a breakdown of population, households, and employment within the nonattainment area boundary are found in Table 1–1.

Figure 1–1. Maricopa County CO Nonattainment Area Boundaries

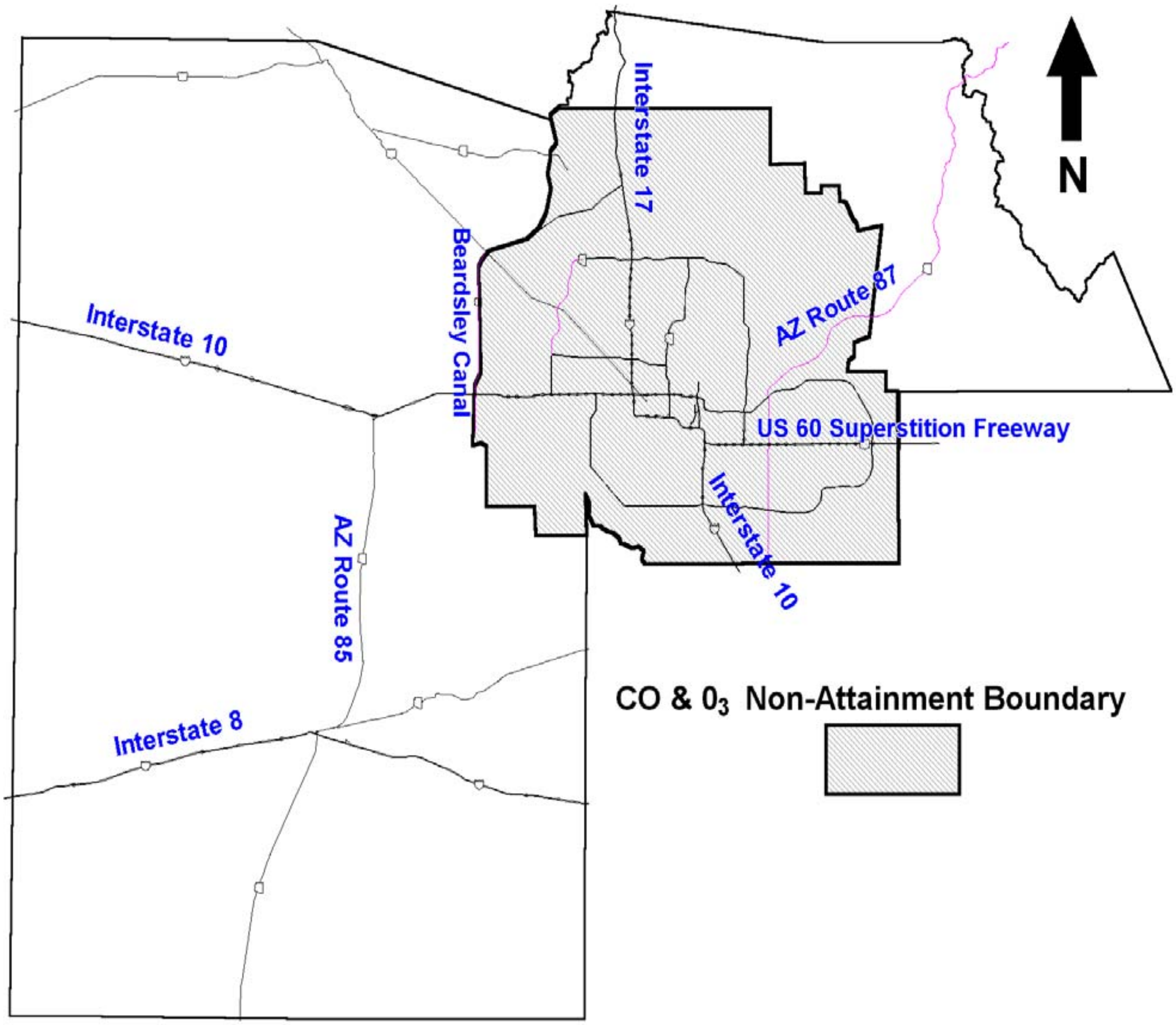


Table 1–1. 1999 Demographic Profile of the CO Nonattainment Area

Parameter	Value
Total Population	2,957,147
Total Households	1,124,469
Total Employment:	1,414,767
– Industrial Employment	313,613
– Office Employment	396,106
– Retail Employment	325,133
– Public Employment	189,263
– Other Employment	190,652

- "Total population" is the sum of resident population in households, resident population in group quarters, transient population, and seasonal population.
- "Total households" is the sum of occupied resident, transient, and seasonal housing units.
- "Industrial employment" includes those jobs in the manufacturing and wholesale trade categories.
- "Office employment" includes finance, consulting, real estate, and insurance. The medical industry is not included.
- "Retail employment" is associated with the retail trade sector of the economy, e.g., department store, grocery store, and restaurant workers.
- "Public employment" includes police, military, museums, schools, government, and libraries.
- "Other employment" is all employment not included in the above categories. Examples include medical, postal, transportation, utilities, and communication.

1.1.4 Agencies and Groups that Prepared and are Responsible for the Inventory

The agency directly responsible for preparing and submitting the Maricopa County nonattainment area 1999 Periodic Carbon Monoxide Emissions Inventory is the Maricopa County Environmental Services Department (MCESD). Carbon monoxide emissions inventories for nonattainment area stationary (point and area) sources and nonroad mobile sources (aircraft and locomotive) were prepared by MCESD. The nonroad equipment source emissions were determined by the EPA in 1990 and were adjusted by MCESD in 1996; the 1996 emissions were then grown to estimate 1999 emissions. The Maricopa Association of Governments (MAG) prepared the onroad mobile source CO emissions inventory. All preparation and quality control contacts are listed in Table 1–2.

Table 1–2. Maricopa County 1999 Periodic CO Emissions Inventory Contacts

Task / Section:	Name and Affiliation	Phone
Emission Inventory Preparation:		
Stationary Point, Area, and Nonroad Mobile Sources	Renee Kongshaug, MCESD	(602) 506-4057
	Bob Downing, MCESD	(602) 506-6790
Transportation Data	Ruey-in Chiou, MAG	(602) 254-6300
Onroad Mobile Sources and Modeling	Roger Roy , MAG	(602) 254-6300
Modeling	Peter Hyde, ADEQ	(602) 207-7642
Quality Assurance / Quality Control:		
Stationary Point, Area, and Nonroad Mobile Sources	Jo Crumbaker, MCESD	(602) 506-6705
Transportation Data/Onroad Mobile Sources and Modeling	Ruey-in Chiou, MAG	(602) 254-6300
External QA	Randy Sedlacek, ADEQ	(602) 207-2300

1.2 Emissions Summary

Average season day CO emissions in the Maricopa County nonattainment area for 1999 are shown in Table 1–3, while annual CO emissions are listed in Table 1–4.

Table 1–3. 1999 Season Daily CO Emissions for the Maricopa County Nonattainment Area

Source Type	Tons CO/ Season Day
Stationary Point Sources	9.09
Area Sources	24.06
Nonroad Mobile Sources	573.95
Onroad Mobile Sources	540.41
Total:	1,147.51

Table 1–4. Annual 1999 CO Emissions for the Maricopa County Nonattainment Area

Source Type	Tons CO/Year
Stationary Point Sources	1,753
Area Sources	5,840
Nonroad Mobile Sources	195,042
Onroad Mobile Sources	(not calculated)

The remainder of this report is organized as follows: Section 2 addresses the stationary point source categories addressed in this inventory. A list of all point sources and their emissions with sample calculations and summary tables can be seen in section 2. Sample point source reports and calculations can be found in Appendix 2. Section 3 provides a complete explanation of each area source category. Methods of determining emissions and references are also provided. Supporting documentation and calculations can be found in Appendix 3. Section 4 addresses the nonroad mobile sources inventory. Aircraft activity, locomotives, and nonroad equipment are included in this section. Nonroad emissions information, growth factors, and nonroad equipment calculations are shown in Appendix 4. Section 5 describes the estimation of the onroad mobile source inventory, while MOBILE5a computer inputs and descriptions can be found in Appendix 5. Section 6 describes the quality assurance program used to ensure that the inventory is accurate and complete. Copies of completed QA checklists documenting errors found and how these errors were corrected are given in Appendix 6.

1.3 References for Section 1

Maricopa Association of Governments. 1999 Demographic Profile for Maricopa County Ozone and Carbon Monoxide Non-Attainment Areas. July 2000.

Maricopa County Environmental Services Department. 1990 Base Year Carbon Monoxide Emission Inventory. August 1993.

Maricopa County Environmental Services Department. 1993 Periodic Carbon Monoxide Emission Inventory. September 1996.

Maricopa County Environmental Services Department. 1996 Periodic Carbon Monoxide Emission Inventory. December 1998.

US Government Office of the Federal Register, National Archives and Records Administration. Code of Federal Regulations. 40 CFR, Volume 56, 56694. Nov. 6, 1991.

US Government Office of the Federal Register, National Archives and Records Administration. Code of Federal Regulations. 40 CFR, Volume 61, 39343. July 29, 1996.

SECTION 2. INDIVIDUAL STATIONARY POINT SOURCES

2.1 Introduction and Scope

Maricopa County Environmental Services Department (MCESD) is the lead agency responsible for compiling this 1999 periodic CO emissions point source inventory. MCESD is also responsible for identifying all point sources within the nonattainment area, documenting the methods used to calculate emissions from each source, and calculating and presenting the results. For the purposes of this inventory, a point source is defined as a stationary operation that meets one or more of the following criteria:

- It emitted 50 short tons or more of carbon monoxide (CO) in 1999; OR
- It was included as a point source in the 1990, 1993 or 1996 CO periodic emission inventories; OR
- It was included as a point source in the 1990, 1993, or 1996 ozone periodic emission inventories and has measurable CO emissions; OR
- It is the only CO source (or one of a few) in a category that would otherwise have been considered an area source.

This section describes the point source data collection techniques and emission estimation methods, and provides summary tables of annual and season-day point source CO emissions. Table 2–1 shows the point source categories to be addressed in a CO emission inventory (U.S. EPA, 1991), along with those that are present in the non-attainment area and thus included in this inventory.

Table 2–1. Individual Point Source Categories of Carbon Monoxide

External Fuel Combustion:	
Utility Boilers	Included
Industrial Boilers	Included
Commercial/Institutional Boilers	Included
Other External Fuel Combustion	Included
Stationary Internal Combustion:	
Gas Turbines	Included
Reciprocating Engines	Included
Cogeneration	Included
Waste Disposal:	
Municipal Waste Combustion:	
Refuse-Derived Fuel	Included
Mass Burn	Not included, not in area
Coal-fired	Not included, not in area
Other	Not included, not in area

Table 2–1. Individual Point Source Categories of Carbon Monoxide (continued)

Industrial Processes:	
Iron and Steel Manufacturing	
Coke Production	Not included, not in area
Coke Pushing	Not included, not in area
Coke Oven Doors	Not included, not in area
Coke Byproduct Plant	Not included, not in area
Coke Charging, Coal Preheater	Not included, not in area
Topside Leaks, Quenching	Not included, not in area
Battery Stacks	Not included, not in area
Sintering	Not included, not in area
Electric Arc Furnaces	Included
Other Process Units	Included
Petroleum Refineries	Not included, not in area
Mineral Products	
Cement	Not included, not in area
Glass	Not included, not in area
Other	Included
Miscellaneous:	
Aircraft/Rocket Engine Firing and Testing	Included

2.2 Compiling the Point Source List

Applying the criteria for identifying point sources described above resulted in a preliminary list of 223 businesses. After a telephone conversation with Larry Biland of U.S. EPA Region IX, it was agreed to exclude sources that (1) emitted less than 5 English tons of CO in 1999, and (2) were not included in prior years' CO emissions inventories. These smaller sources are considered as part of the area source category. Applying this additional criteria narrowed the point source list to 41 individual sources, listed in Table 2–2.

Detailed process-level emissions information for each point source is collected annually by the Maricopa County Environmental Services Department. Each point source is identified by a Maricopa County business identification (ID) number internal to the County's computerized permit database, as well as business name, and physical address as specified in Table 2–2. (Firms whose names have changed since being reported in earlier inventories are noted in the table.) All point source data will be forwarded to the U.S. Environmental Protection Agency for use in the National Emission Inventory (NEI) database. For questions concerning the identification of point sources and their emissions calculations, contact Bob Downing at *bdowning@mail.maricopa.gov*, or (602) 506-6883.

MCESD identified point sources within the nonattainment area through its Environmental Management System (EMS) permit database. Activity levels were determined from annual emission reports, MCESD source inspection reports, or telephone contacts with sources. Table 2–3 lists the point sources by the categories (determined by process-level Source Classification Codes) within which CO emissions were reported.

Table 2–2. 1999 Annual and Season Daily CO Emissions from All Point Sources

Business ID No.	SIC	Business Name	Address	City	ZIP	Annual CO (tons/yr)	Winter Day CO (lbs/day)	
1075	4952	91st Ave. Wastewater Treatment Plant	5615 S. 91st Ave.	Tolleson	85353	25.28	136.6	
3313	4911	APS West Phoenix Power Plant	4606 W. Hadley St.	Phoenix	85043	101.01	1,202.0	*
961	7996	Big Surf	1500 N. McClintock Dr.	Tempe	85281	1.06	0.0	
1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	2301 W. Durango St.	Phoenix	85009	27.48	125.5	
29919	4953	City of Phoenix 27th Avenue Landfill	2800 S. 27th Ave.	Phoenix	85027	30.76	169.0	
40233	9511	City of Scottsdale / Water Services Division	16800 N. Hayden Rd.	Scottsdale	85261	11.49	63.1	
26	5082	Empire Machinery Co.	1725 S. Country Club Dr.	Mesa	85210	22.14	117.2	
1437	3672	Hadco Phoenix Inc. / Sanmina Phoenix Division	5020 S. 36th St.	Phoenix	85040	8.15	52.2	
3536	2051	Holsum Bakery Inc.	408 S. 23rd Ave.	Phoenix	85009	7.25	55.8	
355	3724	Honeywell International Inc. (formerly *AlliedSignal Engines*)	111 S. 34th St.	Phoenix	85034	31.36	172.3	
354	3341	Imsamet of Arizona	3829 S. Estrella Pkwy.	Goodyear	85338	94.17	496.7	
31617	3674	Intel Corp. Chandler Campus (Fab 6)	5000 W. Chandler Blvd.	Chandler	85226	7.31	59.4	
3966	3674	Intel Corp. Ocotillo Campus (Fab 12)	4500 S. Dobson Rd.	Chandler	85248	6.05	40.3	
3300	9711	Luke Air Force Base	14002 W. Marauder St.	Glendale	85309	14.12	110.0	
744	3325	M.E. West Castings Inc.	5857 S. Kyrene Rd.	Tempe	85283	47.67	359.3	
1254	8062	Maricopa Medical Center	2601 E. Roosevelt St.	Phoenix	85008	1.42	24.2	
1414	1442	Mesa Materials Inc. (Mesa)	3410 N. Higley Rd.	Mesa	85205	15.99	73.8	
1415	1442	Mesa Materials Inc. (Phoenix)	7845 W. Broadway Rd.	Phoenix	85043	11.67	53.9	
881	3674	Motorola Inc.	1300 N. Alma School Rd.	Chandler	85224	7.27	46.7	
1151	3674	Motorola Logic & Analog Tech Group	2200 W. Broadway Rd.	Mesa	85202	16.80	100.6	
223	3524	MTD Southwest Inc.	550 N. 54th St.	Chandler	85226	23.78	183.8	
1878	8661	North Phoenix Baptist Church	5757 N. Central Ave.	Phoenix	85012	1.96	15.1	
52382	4911	Ocotillo Power Plant	1500 E. University Dr.	Tempe	85281	82.79	1,054.1	*
212	3674	ON Semiconductor (formerly *Motorola Inc.*)	5005 E. McDowell Rd.	Phoenix	85008	12.47	87.1	
98	4911	Palo Verde Nuclear Generating Station	5801 S. Wintersburg Rd.	Tonopah	85354	20.96	115.1	
1014	3251	Phoenix Brick Yard	1814 S. 7th Ave.	Phoenix	85007	39.31	216.0	
238	3272	Pre-Cast Manufacturing Co.	301 W. Broadway Rd.	Phoenix	85041	1.42	7.4	
1030	2752	Quebecor World-Phoenix Division	1850 E. Watkins St.	Phoenix	85034	31.97	180.4	
3315	4911	Santan Generating Plant	1005 S. Val Vista Dr.	Gilbert	85296	336.71	3,425.5	*
4175	4226	SFPP LP	49 N. 53rd Ave.	Phoenix	85043	5.51	30.3	
3316	4911	SRP Agua Fria	7302 W. Northern Ave.	Glendale	85303	488.74	6,737.6	*
3317	4911	SRP Kyrene Steam Plant	7005 S. Kyrene Rd.	Tempe	85283	39.03	1,619.5	*
101	2011	Sunland Beef Co.	651 S. 91st Ave.	Tolleson	85353	8.91	51.3	
249	3721	The Boeing Company (formerly *McDonnell Douglas Helicopter Systems*)	5000 E. McDowell Rd.	Phoenix	85215	1.82	14.0	
232	7011	The Phoenician Resort	6000 E. Camelback Rd.	Phoenix	85251	33.06	186.1	
234	2023	United Dairymen of Arizona	2036 S. Hardy Dr.	Tempe	85282	26.79	158.4	
201	1442	United Metro Materials Inc. Plant #1	2875 S. 7th Ave.	Phoenix	85041	55.51	355.8	
260	1442	United Metro Materials Inc. Plant #11	3640 S. 19th Ave.	Phoenix	85009	16.03	64.2	
213	1442	United Metro Materials Inc. Plant #12	11920 W. Glendale Ave.	Glendale	85307	15.02	84.9	
403	3354	VAW of America Inc.	249 S. 51st Ave.	Phoenix	85043	11.88	76.2	
20706	3086	Wincup Holdings Inc.	7980 W. Buckeye Rd.	Phoenix	85048	11.34	57.3	
		TOTAL CO EMISSIONS:				**1,753.46**	**18,178.7**	

* Daily CO emissions from peaking power plants were calculated using data for a peak CO season day.

The following is a list of sources that were included in the 1996 CO point source inventory, but that ceased operations before or during 1999:

Business ID No.	SIC	Business Name	Address	City	ZIP
807	4911	Grove Cogeneration Plant	10853 N. Black Canyon Hwy.	Phoenix	85029
173	3325	Magotteaux-Chandler Inc.	24053 S. Arizona Ave.	Chandler	85248
808	4911	Scottsdale Princess Cogen Plant	7575 E. Princess Dr.	Scottsdale	85255

Pinal County, Arizona was contacted for information about major sources within 25 miles of the metropolitan Phoenix non-attainment area boundaries. No sites in Pinal County met the criteria for inclusion as a point source in this inventory. In addition, the Arizona Department of Environmental Quality was contacted to identify any state-permitted source within the metropolitan Phoenix nonattainment area that should be included as a point source; none were identified.

Table 2–3. Point Source CO Emissions, by Category

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
EXTERNAL COMBUSTION:					
Utility Boilers:					
	3313	4911	APS West Phoenix Power Plant	0.07	0.0
	52382	4911	Ocotillo Power Plant	61.18	714.7
	98	4911	Palo Verde Nuclear Generating Station	7.04	38.7
	3316	4911	SRP Agua Fria	447.72	4,869.7
	3317	4911	SRP Kyrene Steam Plant	24.17	844.2
Utility Boilers Total:				540.18	6,467.3
Industrial Boilers:					
	26	5082	Empire Machinery Co.	1.45	5.1
	1437	3672	Hadco Phoenix Inc. / Sanmina Phoenix	8.15	52.2
	3536	2051	Holsum Bakery Inc.	7.25	55.8
	355	3724	Honeywell International Inc.	5.97	32.8
	31617	3674	Intel Corp. Chandler Campus (Fab 6)	6.82	44.4
	3966	3674	Intel Corp. Ocotillo Campus (Fab 12)	6.05	40.3
	744	3325	M.E. West Castings Inc.	5.31	34.3
	1415	1442	Mesa Materials Inc. (Mesa)	1.34	6.2
	1414	1442	Mesa Materials Inc. (Phoenix)	1.97	9.1
	881	3674	Motorola Inc.	7.06	38.8
	1151	3674	Motorola Logic & Analog Technical Group	16.55	90.9
	223	3524	MTD Southwest Inc.	0.08	1.4
	212	3674	ON Semiconductor	11.90	65.4
	1014	3251	Phoenix Brick Yard	0.05	0.3
	1030	2752	Quebecor World-Phoenix Division	31.97	180.4
	101	2011	Sunland Beef Co.	8.91	51.4
	249	3721	The Boeing Company	1.56	12.0
	234	2023	United Dairymen of Arizona	26.79	158.4
	201	1442	United Metro Materials Inc. Plant #1	0.43	2.8
	260	1442	United Metro Materials Inc. Plant #11	0.99	6.3
	213	1442	United Metro Materials Inc. Plant #12	0.90	5.3
	403	3354	VAW of America Inc.	9.08	58.2
	20706	3086	Wincup Holdings Inc.	11.34	57.3
Industrial Boilers Total:				171.91	1,009.1

Table 2–3. Point Source Emissions by Category (continued)

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
EXTERNAL COMBUSTION:					
Commercial/Institutional Boilers:					
	1075	4952	91st Ave. Wastewater Treatment Plant	3.64	33.1
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	0.12	1.3
	3300	9711	Luke Air Force Base	5.06	44.5
	1254	8062	Maricopa Medical Center	0.96	5.3
	1878	8661	North Phoenix Baptist Church	0.06	0.5
	232	7011	The Phoenician Resort	4.06	26.8
Commercial/Institutional Boilers Total:				13.89	111.5
EXTERNAL COMBUSTION TOTAL:				725.98	7,587.9
INTERNAL COMBUSTION:					
Turbines:					
	1075	4952	91st Ave. Wastewater Treatment Plant	0.01	0.1
	3313	4911	APS West Phoenix Power Plant	100.93	1202.0
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	15.39	44.2
	3300	9711	Luke Air Force Base	0.75	4.1
	52382	4911	Ocotillo Power Plant	21.61	339.4
	98	4911	Palo Verde Nuclear Generating Station	0.73	4.0
	3315	4911	Santan Generating Plant	336.71	3,425.5
	3316	4911	SRP Agua Fria	41.01	1,868.3
	3317	4911	SRP Kyrene Steam Plant	14.86	775.6
Turbines Total:				532.01	11,466.3
Reciprocating Engines:					
	1075	4952	91st Ave. Wastewater Treatment Plant	0.02	0.6
	961	7996	Big Surf	1.06	0.0
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	7.70	55.7
	40233	9511	City of Scottsdale / Water Services Div.	11.49	63.1
	26	5082	Empire Machinery Co.	20.68	112.1
	31617	3674	Intel Corp. Chandler Campus (Fab 6)	0.49	15.0
	3300	9711	Luke Air Force Base	0.91	5.0
	1254	8062	Maricopa Medical Center	0.46	19.0
	881	3674	Motorola Inc.	0.20	7.9
	1151	3674	Motorola Logic & Analog Technical Group	0.25	9.7
	1878	8661	North Phoenix Baptist Church	1.90	14.6
	212	3674	ON Semiconductor	0.56	21.7
	98	4911	Palo Verde Nuclear Generating Station	13.18	72.4
	238	3272	Pre-Cast Manufacturing Co.	1.42	7.4
Reciprocating Engines Total:				56.76	384.6
Cogeneration:					
	232	7011	The Phoenician Resort	29.00	159.4
Cogeneration Total:				29.00	159.4
INTERNAL COMBUSTION TOTAL:				617.78	12,010.3

Table 2–3. Point Source Emissions by Category (continued)

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
WASTE DISPOSAL:					
Refuse-Derived Fuel:					
	1075	4952	91st Ave. Wastewater Treatment Plant	21.61	102.8
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	4.27	24.4
	29919	4953	City of Phoenix 27th Avenue Landfill	30.76	169.0
WASTE DISPOSAL TOTAL:				56.65	296.2
INDUSTRIAL PROCESSES:					
Electric Arc Furnaces:					
	354	3341	Imsamet of Arizona	94.17	496.7
	744	3325	M.E. West Castings Inc.	9.00	69.1
Electric Arc Furnaces Total:				103.17	565.8
Other Process Units:					
	744	3325	M.E. West Castings Inc.	33.36	256.0
	4175	4226	SFPP LP	5.51	30.3
	403	3354	VAW of America Inc.	2.80	18.0
Other Process Units Total:				41.67	304.3
Mineral Processes:					
	1415	1442	Mesa Materials Inc. (Mesa)	10.33	47.7
	1414	1442	Mesa Materials Inc. (Phoenix)	14.02	64.7
	1014	3251	Phoenix Brick Yard	39.26	215.7
	249	3721	The Boeing Company	0.26	2.0
	201	1442	United Metro Materials Inc. Plant #1	55.08	353.1
	260	1442	United Metro Materials Inc. Plant #11	15.04	57.9
	213	1442	United Metro Materials Inc. Plant #12	14.12	79.7
Mineral Processes Total:				148.11	820.8
INDUSTRIAL PROCESSES TOTAL:				292.95	1,690.8
MISCELLANEOUS PROCESSES:					
Aircraft/Rocket Engine Firing and Testing:					
	355	3724	Honeywell International Inc.	25.39	139.5
	3300	9711	Luke Air Force Base	7.41	56.4
	223	3524	MTD Southwest Inc.	23.70	182.3
MISCELLANEOUS PROCESSES TOTAL:				56.50	378.2
TOTAL, ALL PROCESSES:[2]				1753.41	18,180.0

[2] Totals are different from Table 2-2 due to rounding.

2.3 Procedures for Estimating CO Emissions from Point Sources

Emission estimates for the point sources are determined from the annual emission inventory reports submitted by the sources. EPA emission factor documents AP-42 (EPA, 1995 *et seq.*), AIRS 450/4-90-003 (EPA, March 1990), and individual source tests are used to quantify emissions. Appendix 2–1 provides sample 1999 process-level emission inventory reports submitted by a source, while Appendix 2–2 includes a sample of emission factors calculated using site-specific source test results.

Control efficiencies were determined by source tests when available and by AP-42 general factors otherwise however no point sources had CO controls. The CO point sources in Maricopa County are not subject to CO limitations, so no rule effectiveness factors were applied.

MCESD calculated the average season day CO emissions by adjusting the annual emissions to the December, January, and February seasonal output percentages and then dividing them by the operating days per year adjusted for the season. (The time frame is different than the normal winter season, because the emissions are reported in quarters, starting with December 1998–February 1999.) The seasonal percentages and the operating days per year were provided by each source. This calculation was done for all sources except the utilities. The utilities are peaking power plants, which means the units operate on demand so the fuel combustion data for specific days are the best representation of a daily emission estimate. The 1999 peak winter day was requested for worst-case scenario purposes. This data was provided by each facility and the calculation is illustrated in Example 1.

The annual and daily 1999 CO emissions estimates are presented in Table 2–3, which follows the two examples. The two examples were provided to show the method used to calculate average season day CO emissions. Example #1 illustrates the calculation of the actual season day CO emissions for a power plant. Example #2 illustrates the calculation of average season day CO emissions for a non-combustion process from a metal industry facility.

2.3.1 Example 1: Natural Gas-Fired Power Plant

SRP Agua Fria
7302 W. Northern Ave.
Phoenix, AZ

General Facility Information:

Salt River Project (SRP) operates a peaking electric generating plant with three gas/oil-fired boilers and three turbines. The plant is brought on-line when extra generating capacity is needed during periods of peak demand. To provide a reasonable calculation, SRP provided its operating schedule for a peak day in 1999 and 2000 for the CO season day during which the most electricity was generated. On this day, three boilers and three gas turbines operated with an assumed 100% load. The AP-42 emission factors for gas-fired utility boilers are 84 lbs CO/million cubic feet (MMCF) of gas, and 84 lbs CO/million cubic feet of gas for turbines. These factors are applied to the daily fuel consumption. AP-42 emission factors for diesel-fired equipment are also used to calculate annual CO emissions. Totals for boilers and turbines are added to obtain the total SRP Agua Fria point source CO emissions. SRP Agua Fria provided the following information:

1. Peak Winter Day fuel consumption under 100% load (HFC):
   - Boilers: 57.97 MMCF
   - Gas Turbines: 22.24 MMCF

2. Annual Fuel Consumption:
   - Boilers: 10,659.8 MMCF of natural gas + 4,970 gallons #2 diesel fuel oil
   - Turbines: 713.3 MMCF of natural gas + 260 gallons #2 diesel fuel oil

   AP-42 Emission Factors:

Boilers, natural gas	(SCC 10100601)	=	84 lbs CO/MMCF
Boilers, #2 fuel oil	(SCC 10100501)	=	5 lbs CO/Mgal
Turbines, natural gas	(SCC 20100201)	=	84 lbs CO/MMCF
Turbines, #2 fuel oil	(SCC 20100101)	=	3.37 lbs CO/Mgal

<u>Annual CO Emissions Calculation</u>:

Natural Gas:

Boilers = 10,659.8 MMCF × 84 lbs/MMCF
= 895,425 lbs/yr

Turbines = 713.3 MMCF × 84 lbs/MMCF
= 59,917 lbs/yr

Total = (895,425 + 59,917) = 955,342 lbs CO/yr
= 477.7 tons CO/yr

#2 Diesel:

Boilers = 4.79 Mgal × 5 lbs/Mgal
= 24 lbs/yr

Turbines = 0.26 Mgal × 3.37 lbs/Mgal
= 0.9 lbs/yr

Total = (24 + 0.9) = 24.9 lbs CO/yr
= 0.01 tons CO/yr

Total Annual Emissions = Natural Gas + Diesel
= 955,342 lbs/yr + 24.9 lbs/yr
= 955,366.9 lbs/yr
= 477.7 tons CO/yr

<u>CO Season Day Emissions Calculation</u>:

Turbine Emissions = 22.24 MMCF × 84 lbs/MMCF
Turbine Emissions = 1,868 lbs/CO day

Boiler Emissions = 57.97 MMCF × 84 lbs/MMCF
Boiler Emissions = 4,869 lbs/CO day

Total CO Season Day Emissions = Total boilers + Total turbines
= 1,868 + 4,869
= 6,737 lb CO/day
= 3.37 tons CO/day

2.3.2 *Example 2: Secondary Aluminum Smelting Furnace*

Imsamet of Arizona
3829 S. Estrella Pkwy.
Goodyear, AZ

General Facility Information:

This secondary foundry facility has two electric arc furnaces (EAFs) and two heat treat furnaces. Carbon monoxide emissions of 21.5 lbs/hr of operation were calculated from stack tests conducted on the electric arc furnaces in 1992. Production activity from this facility stayed essentially constant throughout the year; thus emissions calculations are based on 8760 hours of operation annually.

Annual CO Emissions Calculation:

Source Emissions = Annual activity level × Emission factor = Total lbs CO/year
= 8760 hr/yr × 21.5 lbs CO/hr
= 188,340 lbs CO/yr
= 94.17 tons CO/yr

CO Season-day Emissions Calculation:

$$\text{Source Emissions} = \frac{\text{Annual activity level} \times \text{Emission factor}}{\text{number of activity days}}$$

$$= \frac{8760\ \text{hr/yr} \times 21.5\ \text{lbs CO/hr}}{365\ \text{days/yr}}$$

= 516 lbs CO/day

= 0.26 tons CO/day

2.4 Emission Reduction Credits

Two facilities that closed out their equipment during 1999 notified Maricopa County to request that their emissions continue to be listed in the emission inventory for possible future use as emission reduction credits. The emission reduction credits for carbon monoxide are as follows:

The Scottsdale Princess Cogeneration – 106 tons of pollutants

Anderson Clayton Oilseed Plant – 5.5 tons of pollutants

Therefore, the total emission reduction credits in 1999 are 111.5 tons.

2.5 References

Maricopa County Environmental Services Department (MCESD), 1996. 1993 Base Year Carbon Monoxide Emission Inventory. August 1996.

Maricopa County Environmental Services Department (MCESD), 1999. 1996 Periodic Carbon Monoxide Emission Inventory. September 1999.

U.S. Environmental Protection Agency (US EPA), 1990. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants. EPA-450/4-90-003. March 1990.

U. S. Environmental Protection Agency, 1991. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. U.S. EPA/Office of Air Quality Planning and Standards, Rep. EPA 450/4-991-011, March 1991.

U. S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors, Vol. I & II. AP-42. 1995 *et seq.*

SECTION 3. AREA SOURCES

3.1 Introduction and Scope

The EPA Emission Inventory Improvement Program produced a table (EPA, August 1999) of area source categories which was evaluated for the CO periodic emissions inventory. Maricopa County regulations prohibit residential incineration and open burning at industrial, commercial/institutional, and residential sources, therefore these categories were excluded. Small-scale combustion sources identified in the EPA procedures document (EPA, May 1991) are not addressed in the inventory because suitable emission factors are not available for estimation purposes, activity data are very difficult and expensive to obtain, and the categories are determined to be negligible contributors to emissions.

3.2 Methodology and Approach

Area source emissions are divided into three categories: fuel combustion, waste disposal, and miscellaneous area sources. The Maricopa County Environmental Services Department (MCESD) prepared the area source emission estimates for all area sources and provided quality assurance. Potential and included area sources can be seen in Table 3–1. EPA emission factor documents are used to quantify emissions.

Table 3–1. CO Area Source Categories

Category / Subcategory	Comment
Stationary Source Fuel Combustion:	
Utility	all are point sources
Industrial	included
Commercial/Institutional	included
Residential	included
Waste Disposal, Treatment and Recovery:	
On-Site Incineration:	included
Industrial	included
Commercial/Institutional	included
Residential	not included, illegal
Open Burning:	permitted only
Industrial	not included, illegal
Commercial/Institutional	not included, illegal
Residential	not included, illegal
Miscellaneous Area Sources:	
Other Combustion:	
Forest Wildfires	included
Charcoal Grilling	not quantified, optional
Structure Fires	included
Fire Fighting Training	included
Fireplaces and Woodstoves	included
Aircraft/Rocket Engine Firing and Testing	all are point sources

One of five emission estimation approaches is used to calculate the area source emissions. Some area source emissions were determined by summing the calculated emissions of individual contributing point sources. Other source categories were calculated based on per capita, commodity consumption-related, or level-of-activity approaches.

3.3 Procedures for Estimating CO Emissions from Stationary Area Source Fuel Combustion

The majority of fuel combustion in Maricopa County is natural gas. Small quantities of fuel oil, including blends and waste are used by some industrial sources. The contribution of liquid petroleum gas (LPG) to total CO emissions is considered insignificant in this area.

Maricopa County Environmental Services Department (MCESD) contacted four natural gas distribution companies to collect natural gas distribution data. Three of the distribution companies are retail distribution companies, while one is wholesale. A list of all four natural gas companies, contacts and distribution data can be seen in Appendix 3–1. The data collected were used to estimate emissions by providing levels of natural gas used by each stationary source in the nonattainment area.

Sales data from the wholesale distributor were obtained as a quality assurance check on the retail data. The wholesale distributor reported supplying the three retail suppliers with approximately 39.2 billion cubic feet of natural gas in 1999. This correlates with the total distribution to consumers reported by the three local retail companies. The small difference found can be explained by two factors: 1) the identification of the nonattainment area by the respective companies was approximate; and 2) other small, non-commercial sources of natural gas are being utilized by the local natural gas retailers (e.g., the City of Mesa buys and sells digester gas from the City of Phoenix 91st Avenue Wastewater Treatment Plant).

Each natural gas distribution company provided their seasonal distribution percentages based on the EPA designated seasons of December–February, March–May, June–August, and September–November. The December–February data are used to estimate total fuel consumption during the CO season and to calculate the emissions. It is assumed that all natural gas sold is ultimately used in a combustion process, although each distribution company does lose a minimal amount to leakage, damaged lines, and venting of lines during repairs.

MCESD requested distribution data showing the types of sources receiving the natural gas from the three retail suppliers. This information allowed all sources to be categorized as either Industrial, Commercial/ Institutional, or Residential. The methods used to calculate the emissions from each source category were identical to those used and presented in the 1990 Base Year CO Emissions Inventory (MCESD, 1993). The 1999 annual and average season day CO emissions are presented in Table 3–4 following the example calculations.

3.3.1 Industrial Area Source Fuel Combustion

3.3.1.1 Natural Gas External Combustion

Table 3–2 provides annual and season daily totals for the industrial fuel combustion category. Total natural gas sales for the industrial user category is 10,016.1 million cubic feet (MMCF). This includes the transport category provided by the retail distributors, which is the amount the distributors "transport" for those industrial sources that buy gas directly from the natural gas wholesaler. From this amount, natural gas used by the point sources listed in Section 1 (4,062.2 MMCF for external combustion and 158.5 MMCF used for internal combustion) was subtracted out to avoid double counting. Therefore, a total of 5,795.4 MMCF was used by industrial area sources.

It was assumed that natural gas for area sources is used for internal and external combustion in the same ratio as for point sources. From the data above: (4,062.2 / [4,062.2 + 158.5]) = 96%. Thus 96%, or 5,563.6 MMCF of natural gas was used in area source external combustion. MCESD chose the combustion rate category of 10–100 × 10^6 Btu/hr (SCC 10200602) to be representative of industrial area source natural gas external combustion. The CO emission factor for this equipment is 84.0 lb/MMCF (EPA, July 1998). The 1999 CO emissions from industrial area source natural gas external combustion are thus:

5,563.6 MMCF × 84 lb CO/MMCF = 467,341 lbs/yr = 233.7 tons/yr

3.3.1.2 Natural Gas Internal Combustion

For internal combustion area sources, it was estimated that:

5,795.4 MMCF for all area sources – 5,563.6 MMCF for area source external combustion = 231.8 MMCF of natural gas was used. MCESD chose SCC 20200202 as representative of industrial area source internal combustion, with CO emission factor of 399 lb/MMCF (EPA, July 1998). The 1999 CO emissions from industrial area source natural gas internal combustion are thus:

231.8 MMCF × 399 lb CO/MMCF = 92,488 lbs/yr = 46.2 tons/yr

Therefore the total annual CO emissions from industrial area source natural gas combustion are as follows:
467,341 lbs + 92,488 lbs = 559,829 lbs or 279.9 tons/yr

The procedure for calculating 1999 season daily CO emissions for industrial external and internal combustion is described below. To determine CO season emissions for industrial area sources, the total amount of natural gas distributed in the December–February period was divided by the total amount of natural gas distributed in 1999:

$$\frac{2{,}604.2 \text{ MMCF}}{10{,}016.1 \text{ MMCF}} \times 100\% = 26\%$$

According to Table 5.8–1 of the EPA procedures document (EPA, May 1991), fossil fuel use for industrial area sources occurs throughout a six-day week. Season daily CO emissions are determined as follows:

$$\text{Season Daily CO emissions (lb/day, external)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/week)} \times \text{Season (weeks/yr)}}$$

$$= \frac{467{,}342 \text{ lb} \times 0.26}{6 \times 13} = 1{,}558 \text{ lb/day} = 0.78 \text{ tons/day}$$

$$\text{Season Daily CO emissions (lb/day, internal)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/week)} \times \text{Season (weeks/yr)}}$$

$$= \frac{92{,}488 \text{ lb} \times 0.26}{6 \times 13} = 308 \text{ lb/day} = 0.15 \text{ tons/day}$$

Therefore the total industrial area source natural gas season daily CO emissions are as follows:
1,558 lbs + 308 lbs = 1,866 lbs or 0.93 tons/day

3.3.1.3 Fuel Oil Internal and External Combustion

It was estimated that 5.45 million gallons of diesel and 2.46 million gallons of fuel oil were burned in boilers, heaters, and engines in Maricopa County in 1999. These total amounts are based on a review of all 1999 emission inventories, with the assumption that an additional 5% was used by those sources that either:

- were operating without a permit,
- were permitted by the state but operating within the non-attainment area (certain portable sources), or
- had a county permit, but were not surveyed in 1999 (some very small sources).

Area source fuel oil use was 164,770 gallons, primarily in boilers and heaters (external combustion); while diesel use was 4,969,020 gallons primarily used in industrial and commercial engines (internal combustion). These totals were calculated by subtracting fuel use reported by point sources listed in Section 1 from the total estimated diesel and fuel oil usage. To calculate CO emissions, the total fuel used is multiplied by the relevant emission factor for industrial equipment burning residual oil or diesel, obtained from AP-42 (EPA, 1998). For the external and internal combustion CO emission factors, MCESD chose industrial external combustion boilers (SCC 10200501) at 5 lbs CO /1000 gallons and reciprocating international combustion engines (SCC 20200102) at 130 lbs CO/1000 gallons, respectively.

Fuel Oil External Combustion:

$$\begin{aligned} \text{1999 Total CO Emissions} &= \text{Total Fuel Used} \times \text{CO Emission Factor} \\ &= 164{,}770 \text{ gallons} \times 5 \text{ lb/1000 gallons} \\ &= 824 \text{ lbs or 0.4 tons/yr} \end{aligned}$$

Diesel Fuel Internal Combustion:

1999 Total CO Emissions = Total Fuel Used × CO Emission Factor
= 4,969,020 gallons × 130 lb/1000 gallons
= 645,973 lbs or 323.0 tons/yr

According to Table 5.8–1 of the EPA Procedures Document (EPA, May 1991), fossil fuel use for industrial area sources is uniform throughout the year, six days per week. Average season daily CO emissions were determined as follows:

Fuel Oil (External):

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)}}{\text{6 days/week} \times \text{52 weeks/yr}}$$

= 824 / 312 = 2.64 lbs/day or 0.001 tons/day

Diesel (Internal):

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)}}{\text{6 days/week} \times \text{52 weeks/yr}}$$

= 645,973 / 312 = 2070 lbs/day or 1.03 tons/day

Table 3–2 is a summary of the area source emissions in the industrial category.

Table 3–2. 1999 CO Emissions from Industrial Area Sources

Fuel Combustion Category	**1999 Annual CO Emissions (tons/yr)**	**1999 Season Day CO Emissions (tons/day)**
Natural Gas (External Combustion)	233.7	0.78
Natural Gas (Internal Combustion)	46.2	0.15
Fuel Oil (External and Internal Combustion)	323.4	1.03
Total:	603.3	1.96

3.3.2 Commercial/Institutional Area Source Fuel Combustion

This category of fuel consumption comprises natural gas burned in heating equipment, reciprocating engines, and turbine engines. MCESD assumes that area source natural gas usage for boilers (and similar heating equipment) and for engines is equivalent to the ratio of point source natural gas usage between boilers and engines. The total natural gas usage reported as Commercial/Institutional is 14,202 million cubic feet. Point source fuel use (243.93 MMCF for boilers and 163.19 MMCF for engines) was subtracted from this total to derive a value of 13,795 MMCF used by area sources. The ratio of internal to external combustion for area sources is assumed to be the same as that for point sources (40.1% internal, 59.9% external combustion). Thus:

13,795 MMCF × 40.1% = 5,531.8 MMCF used for internal combustion

13,795 MMCF × 59.9% = 8,263.2 MMCF used in external combustion equipment

3.3.2.1 Natural Gas External Fuel Combustion

A total of 8,263.2 MMCF was estimated to be used in external combustion area sources. This total is multiplied by the CO emission factor of 84 lb/MMCF for SCC 201000201 (EPA, July 1998) to determine the annual emissions.

1999 CO Emissions from Commercial/Institutional Heating = 8,263.2 MMCF × 84 lb/MMCF
= 694,109 lbs or 347.1 tons/yr

Calculation of the CO season daily emissions for commercial/institutional heating uses the December-February natural gas distribution figures shown in Table 3-3.

Table 3–3. Suppliers and Total Distribution of Natural Gas to Commercial/Institutional Sources (Area and Point Sources)

	Million Cubic Feet (MMCF)	
Supplier	**Annual**	**Dec.–Feb.**
Southwest Gas Corp. to "Commercial"	12,467.6	3,230.25
City of Mesa to "Commercial"	1,621.0	518.72
Black Mountain Gas Co. to "Commercial"	113.5	34.05
Total:	**14,202.1**	**3,783.02**

The total season consumption is divided by the annual consumption to determine the seasonal adjustment factor for commercial/institutional external combustion as follows:

$$\frac{\text{December-February cubic feet}}{\text{Total cubic feet}} = \frac{3{,}783.02 \text{ MMCF}}{14{,}202.1 \text{ MMCF}} = 0.27$$

According to Table 5.8–1 of the procedures document (EPA, May 1991), fossil fuel in the commercial/institutional category was used throughout a six-day week. Therefore, the season daily CO emissions from heating are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{694{,}109 \text{ lbs} \times 0.27}{6 \times 13}$$

$$= 2{,}403 \text{ lbs/day or } 1.20 \text{ tons/day}$$

3.3.2.2 Natural Gas Internal Fuel Combustion

Area source commercial/institutional natural gas internal combustion was estimated to be 5,531.8 MMCF in 1999 as explained above. It was assumed that natural gas for area sources is used for internal and external combustion in the same ratio as for point sources. The total natural gas used by reciprocating engine point sources was 173.51 MMCF, or 54.4% of the total internal combustion engines. Thus, the area source usage of 5,531.8 MMCF was multiplied by 54.4% to get 3,009.3 MMCF of natural gas used by area source reciprocating engines. This was multiplied by the CO emission factor to calculate annual emissions.

Reciprocating engine
emission factor used = 423 lb/MMCF* (EPA, July 2000)

*Average of the four CO emission factors given for 2-stroke and 4-stroke lean burn engines, SCC 20200252 and SCC 20200254.

Total 1999 CO emissions
from reciprocating engines = 3,009.3 MMCF × 423 lb/MMCF
= 1,272,934 lbs or 636.5 tons/yr

Seasonal operations in this category were distributed over a seven-day week and assumed to be constant throughout the year. Therefore the average daily CO season emissions are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{1{,}272{,}934 \text{ lbs} \times 0.25}{7 \times 13}$$

$$= 3{,}497 \text{ lbs/day or } 1.75 \text{ tons/day}$$

The natural gas used in reciprocating engines was subtracted from total natural gas usage for the category to derive natural usage for turbine engines:

5,531.8 MMCF total – 3,009.3 MMCF in reciprocating engines = 2,522.5 MMCF burned in turbine engines

Turbine engine
emission factor = 84 lb/MMCF (EPA, April 2000).

Total 1999 CO emissions
from turbine engines = 2,522.5 MMCF × 84 lb/MMCF
= 211,890 lbs or 105.9 tons/yr

The seasonal adjustment factor for natural gas combustion in turbine engines is 25%, as determined above for reciprocating engines. Seasonal operations in this category were distributed over a seven-day week. Therefore the season daily CO emissions are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{211{,}890 \text{ lbs} \times 0.25}{7 \times 13}$$

$$= 582.1 \text{ lbs/day or } 0.30 \text{ tons/day}$$

Internal combustion area source CO emissions (both natural gas reciprocating and turbine engines) are shown below:

Total 1999 CO Emissions = 636.5 + 105.9 = 742.4 tons/yr

Season Day CO Emissions = 1.75 + 0.30 = 2.05 tons/day

3.3.3 *Residential Area Source Fuel Combustion*

Other than wood, the only significant fuel for residential use in Maricopa County is natural gas. Natural gas sales for the residential category of 14,475 million cubic feet (MMCF) were multiplied by an AP-42 CO emission factor of 40 lb/MMCF to determine CO emissions for the year. MCESD applied the CO emission factor for external combustion boilers (residential furnaces; EPA, July 1998). Total 1999 annual residential CO emissions are calculated below:

$$\begin{aligned}\text{1999 CO Emissions from} & \\ \text{Residential Fuel Combustion} &= 14{,}475 \text{ MMCF} \times 40 \text{ lb/MMCF} \\ &= 579{,}000 \text{ lbs/yr or } 289.5 \text{ tons/yr}\end{aligned}$$

The three natural gas companies provided natural gas distribution according to season. The total natural gas distribution for residential use during the winter season (December to February) was 4,044 MMCF. The seasonal adjustment factor was determined as follows:

$$\frac{\text{December–February}}{\text{Annual Total}} = \frac{4{,}044 \text{ MMCF}}{14{,}475 \text{ MMCF}} = 0.28$$

According to Table 5.8–1 of the procedures document (EPA, May 1991), residential fuel combustion is equally distributed throughout the week, so average daily CO-season emissions are determined as follows:

$$\begin{aligned}\text{Season Daily CO Emissions (lb/day)} &= \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}} \\ &= \frac{579{,}000 \text{ lbs} \times 0.28}{7 \times 13} \\ &= 1{,}778 \text{ lbs/day or } 0.89 \text{ tons/day}\end{aligned}$$

Table 3–4. Summary of CO Emissions from Stationary Area Source Fuel Combustion

Stationary Area Source Fuel Combustion Category	1999 Emissions (tons/yr)	CO Season Day (tons/day)
Industrial External Combustion	234.7	0.78
Industrial Internal Combustion	366.4	1.17
Commercial/Institutional External Combustion	347.1	1.20
Commercial/Institutional Internal Combustion	742.4	2.05
Residential External Combustion	289.5	0.89
Total:	**1,980.1**	**6.09**

3.4 Procedures for Estimating CO Emissions from Waste Disposal, Treatment and Recovery

CO emissions from waste disposal, treatment, and recovery processes are grouped into two parts: (1) emissions from on-site incineration sources; and (2) emissions from industrial, commercial/institutional, and residential open burning. On-site incineration emissions are addressed below while open burning emissions are included in Section 3.4.2.

3.4.1 On-Site Incineration

This category is separated into three classifications of on-site incineration: industrial, commercial/ institutional, and residential. Industrial incinerators are defined as incinerators used to burn materials from all manufacturing establishments in SIC groups 20–39 and which are not classified as point sources. Industrial and commercial/institutional incinerators are located at crematories and veterinarian facilities. Commercial/institutional incinerators burn refuse and paper products from wholesale and retail trade establishments, service establishments, and medical waste from hospitals and laboratories. Residential incinerators burn refuse and paper products from homes and apartment complexes with less than 20 units.

All incinerators are required to be permitted by Maricopa County Environmental Services Department (MCESD). A total of 29 commercial/institutional incinerators operated in Maricopa County during 1999. There was no home or apartment complex in Maricopa County with less than 20 units that operated an incinerator.

The data used to calculate emissions from incinerators were obtained from 1999 emission reports which were submitted to Maricopa County Environmental Services Department (Appendix 3–2). MCESD requires sources to submit annual reports on emissions from processes and/or materials used at each source. For those sources without 1999 emissions reported, the most recent reported data were used.

Annual carbon monoxide emissions for each source are determined by multiplying the total amount of materials burned by the CO emission factor (EPA, October, 1996). Emission factors for incineration were obtained from AP-42, Chapter 2: Solid Waste Disposal, 2.1 Refuse Combustion (EPA, Oct. 1996). Emissions were determined by summing the total annual tons incinerated, and then using the following calculation:

Annual CO Emissions
from Onsite Incineration = Annual Tons Burned × Emission Factor
= 1,845 tons × 10 lbs/ton
= 18,450 lbs/yr or 9.23 tons/yr

Maricopa County Environmental Services Air Pollution Control Regulations Rule 313 does not require controls for CO; so rule penetration and rule effectiveness are not reflected in the CO emission calculations. Therefore, the total annual CO emissions from incinerators are 9.23 tons/year. Based on the average of the operating schedules shown on each source's emissions report, the seasonal adjustment factor of 0.25 is used in the formula. An average operating schedule of 5 days a week is used. The calculation below illustrates 1999 CO season daily emissions.

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{18{,}450 \text{ lbs} \times 0.25}{5 \times 13}$$

$$= 71.0 \text{ lbs/day or } 0.04 \text{ tons/day}$$

3.4.2 Open Burning

This section includes emissions from controlled open burning which are regulated by the Maricopa County Air Pollution Control Rules and Regulations. Permits are used to regulate the type of burning, manner, days and times. MCESD issues permits primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, fire hazard/training, pest prevention, and trees (air curtain destructors). Amounts of material burned in 1999 are estimated using the burn permits issued. To determine total CO emissions in this category, calculations are made for each type of burning and then added together. Fire training is included in the following section with structure fires.

CO emission factors are given in pounds of CO per ton of vegetation burned. The EPA fuel loading factors provide an estimate of tons of specific vegetation produced per acre (amount produced is considered the amount burned). Emission factors and fuel loading factors were obtained from AP-42 Table 2.5–5 (EPA, Jan. 1995). An excerpt of the factors used is reprinted in Table 3–5.

Table 3–5. Selected Emission Factors and Fuel Loading Factors for Open Burning of Agricultural Materials

Refuse Category	CO Emission Factor (lb CO/ton)	Fuel Loading Factor (waste production, ton/acre)
Weeds: Unspecified	85	3.2
Tumbleweeds	309	0.1
Orchard Crops: Citrus *	81	1.0
Orchard Crops: Unspecified	52	1.6
Field Crops: Unspecified	117	2.0

* The weight of citrus trees (the fuel-loading factor) is estimated to be 500 lbs/tree (MCESD, Aug. 1993).

A summary of the burn permit data is shown in Table 3–6. The calculation of emissions from the burning of ditch banks and fence rows is included for illustration.

Table 3–6. Burn Permit Data Used to Estimate Material Quantities Burned Within the Nonattainment Area

Type of Burning	Amount of Burning Annual (1999)	CO Season
Ditch Banks and Fence Rows	5,935,448 ft	(not allowed)
Tumbleweeds	2,155 piles	32 piles
Air Curtain Destructors	4,044 trees	1,040 trees
Land Clearance	6397.16 acres	66.12 acres
	59 piles	24 piles
Pest Prevention	55 acres	55 acres

3.4.2.1 Burning of Agricultural Ditch Banks and Fence Rows

According to air quality investigators at MCESD, ditch bank and fence row widths are five to ten feet and four feet respectively. These permits are issued for one year and burning occurs at least twice a year. Since there is no data kept regarding actual width, an average of seven feet was assumed for an equal prevalence of ditch banks and fence rows. It was assumed that the total permitted length was within the nonattainment area, or within 25 miles, so the entire length was used in the calculation.

To calculate the amount of material burned on ditch banks and fence rows, MCESD estimated the area burned and multiplied that by the fuel loading factor (see Table 3–6 above) which relates acres to tons of material. The acres of ditch banks and fence rows burned are estimated as follows:

Lengths specified in permits total = 5,935,448 ft

Acres specified = (5,935,448 ft length × 7 ft width × 2 burns/yr × (1acre / 43,560 ft^2)
= 83,096,272 / 43,560
= 1,907.63 acres

The following formula is used to convert the acres of ditch banks and fence rows burned to tons of unspecified weeds burned:

Total tons burned = 1,907.63 acres × 3.2 tons/acre = 6,104.4 tons/yr

Total 1999 CO from Ditch Bank and Fence Row burning = 6,104.4 tons × 85 lb CO/ton
= 518,874 lb CO = 259.44 tons CO/yr

Since ditch bank and fence row burning is not allowed from November to February each year, the daily emissions during the CO season are zero.

3.4.2.2 Burning of Tumbleweeds

Permittees are required to pile tumbleweeds before burning. Tumbleweed burn permittees specify the amount burned in piles. A pile of tumbleweeds fifteen feet in diameter and five feet high was estimated by the Maricopa County/University of Arizona Cooperative Extension Service to weigh 200 lb (MCESD, 1993). This is the same as the AP-42 fuel-loading factor for 1 acre.

In 1999, it was estimated that 2,155 piles or acres of tumbleweeds were burned in the Maricopa County nonattainment area from burn permit data. Using the AP-42 fuel-loading factor of 0.1 ton/acre for Russian thistle (tumbleweed), the total weight burned is calculated as follows:

2,155 acres × 0.1 tons/acres = 215.5 tons

Emissions are calculated according to the following formula:

Annual Tumbleweed emissions = tons burned × emission factor

Total 1999 CO emissions from tumbleweed = 215.5 tons/yr × 309 lb CO/ton burned

= 66,590 lbs/yr or 33.3 tons/yr

Tumbleweed burn permits are valid for one month. Daily season emissions were determined using the permits issued between December and February. Of the 2,155 acres for which permits were issued in 1999, 32 acres were permitted in the winter. Burning was considered to have occurred evenly during the two issuance months. In the same manner as above, the total weight burned is estimated at (32 acres × 0.1 tons/acres = 3.2 tons burned) and CO season emissions from tumbleweed burning are calculated as follows.

CO season emissions from burning tumbleweeds = tons burned × emission factor

= 3.2 tons × 309 lb CO/ton = 989 lb CO/yr

Burning is normally allowed only on the five weekdays. Season daily emissions were calculated according to the following example:

$$\text{Season Daily Emissions (lb)} = \frac{\text{Seasonal Emissions (lb)}}{\text{season operation days}} = \frac{\text{989 lb CO}}{\text{60 days/CO season}} = \text{16.48 lb/day or 0.01 tons/day}$$

3.4.2.3 Burning of Trees

The Maricopa County/University of Arizona Extension Service Agricultural Agents (MCESD, 1993) estimated the weight of citrus trees to be 500 lb/tree, assuming trees were mature, partially dried and included trunk, limbs and bulk of roots. In 1999, three burn permits were issued for 4,044 trees. Using the fuel-loading factor provided by the agricultural agents, the total weight burned is calculated as:

500 lb/tree × 4,044 trees / (2000 lb/ton) = 1,011 tons

No CO emission factors are available for air curtain destructor burning of trees. Citrus tree emission factor from AP-42's Open Burning section was used.

CO Emissions from burning trees = tons of wood × emission factor

= 1,011 tons × 81 lb CO/ton = 81,891 lbs/yr or 40.9 tons/yr

Since burn permits for trees are valid for only one month, CO season daily emissions are estimated based on the permits issued during the winter season. Only one permit was issued in 1999 during December, for 1,040 trees. It is assumed the trees were burned in one month.

$$\text{Season daily emissions from burning trees} = \frac{260 \text{ tons} \times 81 \text{ lb CO/ton}}{5 \text{ days/week} \times 4 \text{ weeks/month}}$$

$$= 1053.0 \text{ lb/day or } 0.53 \text{ tons/day}$$

3.4.2.4 Burning for Land Clearance

Land clearance burning is comprised of burning assorted brush, grasses and some tree waste. Tree limbs and trunks larger than 6" in diameter are required to be removed. The natural vegetation of the area is desert, so it was assumed the vegetation burned was equal to "unspecified weeds" for choosing fuel-loading and emission factors. Based on 1999 burn permit information, 6397.16 acres were burned for land clearance, plus 59 piles. Assuming a pile is equivalent to an acre, as with tumbleweed, the total burned is 6,456.16 acres. Using the AP-42 fuel-loading factor of 3.2 tons/acre for "unspecified weeds," the weight burned was calculated in tons.

Tons of "unspecified weeds" burned for land clearance = 6,456.2 acres × 3.2 tons/acre = 20,660 tons

Total 1999 CO emissions from burning for land clearance = tons burned × emission factor
= 20,660 tons × 85 lb CO/ton
= 1,756,075 lb CO/yr or 878.0 tons CO/yr

Land clearance burning permits are valid for one month. Six land clearance burn permit for a total of 90.12 acres were issued during the CO season in 1999. They were issued between December and February, so it was assumed the burns occurred within those 3 months.

Tons of CO from burning for land clearance = tons burned × emission factor

$$= \frac{90.12 \text{ acre} \times 3.2 \text{ tons/acre} \times 85 \text{ lb CO/ton}}{3 \text{ months} \times 5 \text{ days/week} \times 4 \text{ weeks/month}}$$

$$= 408.54 \text{ lb CO/ day or } 0.20 \text{ tons CO/day}$$

3.4.2.5 Pest Prevention

Pest prevention burning is comprised of assorted agricultural crops. One permit for 55 acres was issued in 1999. Since the crop wasn't described, an average fuel-loading factor from "unspecified field crop" and "unspecified orchard crop" of 1.8 tons/acre was used.

55 acres × 1.8 tons/acre = 99 tons

The emission factor used to calculate emissions from pest prevention burning was averaged from the above-mentioned categories. The permit, only valid for one month, was issued during the CO season, so assumed all emissions are in one month.

Total CO emissions from burning for pest prevention = tons burned × emission factor

= 99 tons × 84.5 lb/ton
= 8,365.5 lb/yr = 4.2 tons/yr

$$\text{1999 CO season daily emissions pest prevention} = \frac{\text{8,365.5 lb CO}}{\text{5 day/wk} \times \text{4 wk/month}}$$

= 418.28 lb CO/day or 0.21 tons/day

3.4.2.6 Summary of CO Emissions from Managed Burning

Total CO emissions from open burning are obtained by summing the emissions from each type of burning. The results are shown in Table 3–7.

Table 3–7. Summary of CO Emissions From Managed Burning

Type of Burning	Annual 1999 CO Emissions (tons/yr)	1999 Season Daily CO Emissions (lbs/day)
Ditch banks and fence rows (unspecified weeds)	259.4	0.0
Tumbleweeds	33.3	0.01
Air Curtain Destructors (citrus trees)	40.9	0.53
Land clearance (unspecified weeds)	878.0	0.20
Pest Prevention (unspecified crops)	4.2	0.21
Totals:	1,215.8	0.95

3.5 Procedures for Estimating CO Emissions from Miscellaneous Area Sources – Other Combustion

3.5.1 Calculation of Emissions from Forest Fires

The Arizona State Land Department provided the number of wildfires that occurred in and around Maricopa County in 1999. Thirty-three wildfires occurred, burning a total of 192 acres. EPA CO emission factor, 1570 kg/hectare or 1,397.82 lb/acre is used to calculate the emissions (EPA, 1996). The emission factor includes the fuel-loading factor.

Annual CO emissions = 192 acres × 1,397.82 lb/acre = 268,380 lbs CO/yr

= 134.2 tons CO/yr

Assuming that the fires occurred evenly throughout the year for obtaining CO season day emissions:

$$\text{CO daily emissions} = \frac{\text{268,380 lbs/yr} \times 0.25}{7 \times 13} = \text{737.3 lbs CO/day or 0.37 tons CO/day}$$

3.5.2 Calculation of Emissions from Fireplaces and Wood Stoves

EPA CO emission factors for burning wood in fireplaces and wood stoves are given for tons of wood burned. To determine CO emissions during 1999 for the Maricopa County nonattainment area, MCESD kept constant the emissions that were estimated for 1996. This was done due to the Maricopa County Wood Burning Ordinance that had been put into place September 30, 1994. Although it was anticipated that the ordinance would create a decrease in emissions, there was no concrete evidence to draw data from. Therefore, it was concluded the most conservative course would be to assume the emissions stayed constant. For clarity, how emissions were calculated in the 1996 emission inventory is described below. A few minor errors were discovered in the 1996 inventory, and they were corrected to reflect more accurate emission estimations below. The method for estimating residential wood consumption described in the procedures document (EPA, May, 1991) was used to estimate CO emissions in this category.

3.5.2.1 Proportion of Residential Units With Wood-Burning Devices

Survey data collected in Maricopa County in 1996 was used to calculate emissions from residential woodburning (MAG, 1997). Of the 1,483 surveys, 461 or 31.1% reported having woodburning devices and 295 or 64% used wood. The survey purpose included gathering data on what types of wood are burned and wood-burning device activity.

Number of Fireplaces:

According to the 1994 demographic data provided by MAG, there were 1,005,529 residential housing units in the Maricopa County nonattainment area. The survey in 1996 indicated that of the residences surveyed, there were 398 reported fireplaces out of 461 woodburning devices, or 86.3% (MAG, 1997). Of that 398, 255 or 64.1% use wood in their fireplaces. The number of residential fireplaces contributing emissions for 1999 is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 houses × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices
# of fireplaces = 312,720 devices × 0.863 fireplaces
= 269,877
# of active fireplaces = 269,877 fireplaces × 0.641 fraction that burns wood = 172,991

Number of Wood Stoves:

The number of wood stoves was determined similarly. Out of the 461 returned surveys that had woodburning devices, 16, or 3.5%, had woodstoves and 10 (62.5%) used them to burn wood. The number of residential woodstoves is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices

# of woodstoves = 312,720 devices × 0.035
= 10,945

# of active woodstoves = 10,945 woodstoves × 0.625 fraction that burns wood = 6,841

Number of Barbecue (BBQ) / Firepits:

The number of BBQ/firepits was determined similarly. Out of the 461 returned surveys that had woodburning devices, 47, or 10.2%, had firepits and 30 (63.8%) used them to burn wood. The number of residential firepits is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 houses × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices

# of firepits = 312,720 devices × 0.102
= 31,897

# of Active Firepits = 31,897 firepits × 0.638 fraction that burns wood = 20,351

3.5.2.2 Density and Types of Wood Burned in Maricopa County

Types of wood burned in Maricopa County were also collected during the 1996 survey. Types of wood and the composite density were calculated and the information is provided in Table 3–8. The weighted average density was calculated as follows:

$$\text{Weighted Average Density} = \frac{(144 \times 42.33) + (105 \times 29.48) + (103 \times 18.8) + (13 \times 31.6) + (2 \times 40)}{367}$$

The composite densities listed for hardwood and softwood are a weighted average of densities listed in Table 3–9.

Table 3–8. Density of Wood Types Used in Wood-burning Devices in Maricopa County

Wood Type	Number of Uses from Survey	Composite Density (lb/ft^3)
Hardwood (Mesquite and Gambel Oak)	141	42.33
Softwood (Junipers and Ponderosa Pine)	105	29.48
Processed Logs	103	18.8
Miscellaneous (broken furniture and scrap; used density of Junipers and Ponderosa Pine)	13	31.6
Pellets	2	40
Weighted Average Density:		**31.66**

The US Forest Service (USFS, 1993) provided MCESD with the following mix of tree species harvested for firewood in Arizona and sold in the Maricopa County area. The mix and composite wood density of the various types of wood burned in Maricopa County are shown in Table 3–9. Composite wood density (CWD) combines the percentage of each type of firewood and its density into a single factor, and is calculated according to the following formula:

$$\text{CWD} = \Sigma\,[\,(\%\text{ wood species}_i) \times (\text{density}_i)\,]$$

Table 3–9. Wood Mix and Composite Wood Density (CWD) for Wood Species Used for Firewood

Tree Species	% of Total Wood Burned	Density (lb/ft^3)	Composite Wood Density (lb/ft^3)
Both Junipers (Mean)	60 %	30.2	18.1
Ponderosa Pine	20 %	26.3	5.3
Mesquite	10 %	43.7	4.4
Gambel Oak	5 %	39.6	2.0
Pinon Pine and other misc. species	5 %	31.6	1.6

3.5.2.3 Volume and Quantity of Wood Burned in Maricopa County

The frequency and quantity of wood burned in fireplaces in the Maricopa County nonattainment area was also gathered in the 1996 survey (MAG, 1997). Survey respondents were asked the frequency they use their wood-burning devices and the number of logs burned for each use. Using the mean range of the survey results for an average, there are 11.3 uses per household per year and 3.1 logs are burned per use. The estimated number of cords of wood burned in residential fireplaces in the Maricopa County nonattainment area in 1999 was calculated as:

Quantity of Wood
Burned in Fireplaces = 172,991 active fireplaces × 11.3 uses/yr × 3.1 logs/use × 0.17 ft^3/log
= 1,030,179 ft^3/yr

Mass of Wood
Burned in Fireplaces = 1,030,179 ft^3 × 31.57 lb/ft^3
= 32,522,751 lbs wood/yr
= 16,261.38 tons wood/yr

Similarly, the amount of wood burned in woodstoves was calculated. Using the mean range of the survey results for an average, there are 12.8 uses per household per year and 2.3 logs are burned per use.

Quantity of Wood
Burned in Woodstoves = 6,841 active woodstoves × 12.8 uses/yr × 2.3 logs/use × 0.17 ft^3/log
= 34,237 ft^3

Mass of Wood
Burned in Woodstoves = 34,237 ft^3 × 31.57 lb/ft^3
= 1,080,862 lbs wood/yr
= 540.43 tons wood/yr

Additionally, the amount of wood burned in firepits was calculated. Using the mean range of the survey results for an average, there are 7.6 uses per household per year and 2.5 logs are burned per use.

Quantity of Wood
Burned in Firepits = 20,351 active firepits × 7.6 uses/yr × 2.5 logs/use × 0.17 ft^3/log
= 65,734 ft^3

Mass of Wood
Burned in Firepits = 65,734 ft^3 × 31.57 lb/ft^3
= 2,075,222 lbs wood/yr
= 1,037.61 tons wood/yr

3.5.2.4 Annual CO Emissions from Fireplaces, Woodstoves, and Firepits

The carbon monoxide emission factor for residential fireplaces is 252.6 pounds CO per ton of wood fuel taken from the updated Section 1.9 of AP-42 (EPA, January 1995), dated October of 1996. Since the amount of wood burned in fireplaces is estimated to be 17,877.63 tons annually, the total tons of CO from fireplaces is:

$$\text{Tons of CO from fireplaces} = \frac{\text{16,261.38 tons of wood} \times \text{252.6 lb/ton}}{\text{2,000 lb/ton}} = \text{2,053.81 tons CO/yr}$$

The carbon monoxide emission factor for conventional residential wood stoves was calculated as a weighted average. The weighted average emission factor was based on 80% as conventional, noncatalytic, catalytic, and masonry stoves and 20% as certified and exempt pellet stoves. The percentages were taken from the survey. The following calculation shows how the emission factor was calculated by weighted average using AP-42 emission factors for the various wood stove units (EPA, Oct. 1996).

$$\text{Wood Stoves CO Emission Factor} = 0.8 \times [(230.8 + 140.8 + 104.4 + 149)/4] + 0.2 \times [(39.4 + 52.2)/2)]$$

$$\text{Wood Stoves CO Emission Factor} = 125 + 9.16 = 134.16 \text{ lb/ton}$$

$$\text{Tons of CO from conventional wood stoves} = \frac{\text{540.43 tons} \times \text{134.16 lb/ton}}{\text{2,000 lb/ton}} = \text{36.25 tons/yr}$$

For firepits, the emission factor used for fireplaces was used to estimate emissions. It was assumed these two devices generate similar emissions as they both lack controls.

$$\text{Tons of CO from firepits} = \frac{\text{1,037.61 tons of wood} \times \text{252.6 lb/ton}}{\text{2,000 lb/ton}} = \text{131.05 tons/yr}$$

3.5.2.5 CO Season Daily Emissions from Fireplaces and Wood Stoves

It is assumed that 90 percent of the wood burned in Maricopa County is burned in the months of November through February (121 days). These months represent the holiday season and the coldest months of the year. As mentioned earlier the use of fireplaces and wood stoves is primarily for aesthetic purposes.

Determining the CO season typical daily CO emissions requires that a Seasonal Adjustment Factor (SAF) be calculated. This SAF and daily CO emissions are determined based on Section 5.8 and 5.9 of the Procedures document (EPA, May 1991). Calculations are shown below.

$$\text{SAF} = \frac{\text{Peak CO Season Activity)} \times \text{12 months}}{\text{Annual Activity} \times \text{Peak CO Season months}}$$

$$= \frac{90\% \times \text{12 months}}{100\% \times \text{4 months}}$$

$$= 2.7$$

Fireplace and Woodstove CO Emissions for a Typical CO Season Day

= Fireplace and Woodstove Annual Emissions × (SAF) / Annual Activity

= (2,053.81 tons/yr + 36.25 tons/yr) × 2.7 / [(7 days/week) (52 weeks/yr)]

= 15.50 tons CO/day

CO Season Daily Emissions from Firepits

It is assumed that firepits are used evenly throughout the year therefore the annual emissions are divided by 365. The calculation is as follows:

CO Season Daily Emissions = 131.05 tons / 365 = 0.36 tons/day

3.5.3 Calculation of Emissions from Structure, Motor Vehicle, and Vegetation Fires

This section includes emissions from structure, motor vehicle, and vegetation fires. Data was compiled by a survey to all fire departments in the nonattainment area. A complete list was obtained from the Arizona Department of Emergency Services. The request letter and the survey form that was addressed to the directors of these fire departments are included in Appendix 3–3. The data requested included the number of structural, vehicle, and vegetation fires. All of the data supplied were provided on the surveys sent out to the respective fire departments. Eighteen permits obtained for fire training were included in the number of structure fires. Not all fire departments returned the survey, so data from a previous survey (1996,1994, 1993, or 1990 in that order of preference) was used. It is important to note that these emissions may be overstated because the fire data may only represent a partial burn.

The CO emission factor applied to the structure fires can be seen in Table 3–10 below (EPA, July 1999). Estimates of the material burned are obtained by multiplying the number of structure fires by a fuel-loading factor of 1.15 tons of material per fire (EPA, July 1999).

The automobile fire CO emission factor was developed in California Air Resources Board's Methods For Assessing Area Source Emissions (CARB, 1997). It includes a combination of average car body weight and components, and assumes that 60% of the fires included tires. With the assumption that a car's components weigh 500 lbs, the following emissions were calculated:

CO Emissions (Body of Automobile) = 4901 fires/yr × 2.5 lbs CO/fire = 12,253 lbs CO/yr

CO Emissions (Components) = 500 lbs/avg. car × 4,901 fires/yr × 60%
= 91,894 lbs CO

The emission factor used for vegetation burned is 85 lb CO/ton with an AP-42 fuel loading factor of 3.2 tons/acre for "unspecified weeds" (EPA, 1995). Vegetation burned includes fences, alley, trash, and yard fires of accidental occurrence that the fire department has records on. An average size of the fire is unknown so it was assumed to be equal to a tenth of an acre. The number of fires in the vegetation category was multiplied by 0.1.

No seasonal data are available to estimate a seasonal factor. Fires are assumed to occur equally throughout a seven-day week. Therefore, the total emissions per year are divided by 365 to estimate a typical day in the CO season.

Table 3–10. Total CO Emissions from Structure, Automobile, and Vegetation Fires

Type of Fire	Number of Fires	Fuel Loading Factors	CO Emission Factors	Annual CO Emissions (tons/yr)	Peak CO Season Emissions (tons/day)
Structure	3,769	1.15 tons/structure	60 lb/ton	130.0	0.36
Automobile	4,901	500 lbs (avg. wt of car)	2.5 lbs/car 125 lbs/ton	52.1	0.14
Vegetation	6,967	3.2 tons/acre	85 lb/ton	94.7	0.24
Total	**15,637**	———	———	**276.8**	**0.74**

3.6 Summary of All Area Source Emissions

A summary of emissions contributed by area sources is provided in Table 3–11.

Table 3–11. Summary of All Area Source CO Emissions

Report Section	Area Source Fuel Combustion Category	Annual CO Emissions (tons/yr)	Season Day CO Emissions (tons/day)
Stationary Source Fuel Combustion:			
3.3.1	Industrial External Natural Gas Combustion	233.7	0.78
	Industrial Internal Natural Gas Combustion	46.2	0.15
	Industrial External Fuel Oil Combustion	0.4	0.00
	Industrial Internal Fuel Oil Combustion	323.0	1.03
3.3.2	Commercial/Institutional		
	External Combustion	347.1	1.20
	Internal Combustion	742.4	2.05
3.3.3	Residential; External Combustion	289.5	0.89
Waste Disposal, Treatment And Recovery:			
3.4.1	On-Site Incineration	9.2	0.04
3.4.2	Open Burning	1,215.9	0.95
Miscellaneous – Other Combustion:			
3.5.1	Wildfires	134.2	0.37
3.5.2	Fireplaces, Wood Stoves, and BBQ/Firepits	2,221.1	15.86
3.5.3	Structure, Motor Vehicle, and Vegetation Fires	276.8	0.74
TOTALS		**5,839.5**	**24.06**

3.7 References for Section 3

California Air Resources Board. Emissions Inventory Procedural Manual, Volume III: Methods for Assessing Area Source Emissions. October 1997.

Maricopa Association of Governments. 1994 Regional PM_{10} Emission Inventory for the Maricopa County Nonattainment Area. 1997.

Maricopa Association of Governments. Maricopa County Demographic Information, Ozone and CO Non-Attainment Areas, Year 1999. July, 2000.

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Maricopa County Environmental Services Department. 1996 Carbon Monoxide Periodic Emission Inventory. October 1999.

U.S. Environmental Protection Agency. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants. EPA-450/4-90-003. March 1990.

U. S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Vol. I & II, AP-42, 1995.

U. S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition Vol. I & II, AP-42 Supplements A, B, C, D, and E, October 1996- July 2000.

U.S. Environmental Protection Agency. Introduction to Area Source Emission Inventory Development, Vol. III, EIIP, August 1996.

U.S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. I. EPA-450/4-91-016. May 1991.

U.S. Environmental Protection Agency. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. EPA-450/4-91-011. March 1991.

SECTION 4. NONROAD MOBILE SOURCES

4.1 Introduction and Scope

The nonroad mobile source inventory includes emissions from aircraft, locomotives, diesel equipment, 4-stroke gasoline equipment, and 2-stroke gasoline equipment. This inventory does not account for aircraft activity at unpaved airports because the activity is considered insignificant. Coal-burning locomotives are not included because there are none in the nonattainment area. Emissions from snowplows and snowmobiles were not included because the Phoenix area does not receive enough snow. Only recreational marine vessels were included, since there aren't any navigable bodies of water suitable for goods transportation.

Aircraft emissions were calculated using survey information provided by the airports and incorporating these data into the EPA's FAA Aircraft Engine Emissions Database (FAEED). Survey information was also used for calculating locomotive emissions. Emission estimates for diesel equipment, 4-stroke and 2-stroke gasoline equipment sources were developed using the Energy and Environmental Analysis, Inc. study prepared for EPA's Office of Mobile Sources (OMS). Nonroad gasoline equipment includes recreational vehicles, construction equipment, industrial/commercial equipment, lawn and garden equipment, and farm equipment. Nonroad diesel equipment includes construction equipment, industrial/commercial equipment, and farm equipment. These emissions estimates were adjusted to reflect growth and conditions specific to the Phoenix nonattainment area as explained in section 4.4. Nonroad emission calculations include 1999 annual and average daily CO.

4.2 Procedure for Estimating Emissions from Aircraft

Emission factors for estimating aircraft emissions were determined using the FAA Aircraft Engine Emissions Database (FAEED). Airport operations data for 1999 were collected from the airports through surveys sent by mail. All airports except Stellar Aviation responded, therefore 1996 operation numbers were used for Stellar Aviation. Table 4–1 shows those general aviation airports included in this inventory and the number of 1999 operations (defined as a landing or a take-off). An LTO is a landing and a take-off cycle, and is used in FAEED to calculate emissions. Therefore, to obtain LTOs, the number of airport operations is divided by two. The operations data provided by the airports are included in Appendix 4-1.

4.2.1 Emission Factors

The alternative fleet-average method, outlined in Procedures for Emission Inventory Preparation Volume IV: Mobile Sources (EPA, 1992) was used to calculate emissions for all types of aircraft. The emission factors are shown below in Table 4–2. When there was more than one type of engine for a specific aircraft, the engine having maximum CO emissions at idle was used. Emission factors were then back calculated by taking emission estimates from FAEED and dividing by LTO cycles. For this method, the emission factors for all unique engines in a certain aircraft type category were averaged since they were reported together in FAEED.

Table 4–1. General Airports and Operation Data

Airport	1999 Operations	1999 LTOs
Chandler Municipal Airport	221,018	110,509
Stellar Aviation	60,000	30,000
Glendale Municipal Airport	130,055	65,028
Phoenix Goodyear Airport	136,278	68,139
Luke Air Force Base	168,520	84,260
Mesa Falcon Field Airport	263,988	131,994
Deer Valley Airport	290,791	145,396
Scottsdale Airport	230,571	115,286
Phoenix Sky Harbor	557,458	278,729
Williams Gateway Airport	236,278	118,139
Total	**2,294,957**	**1,147,480**

Specific air carrier operations in 1999 and aircraft type information for 1998 from Sky Harbor was used for these emission factors. The air taxi emission factor was determined using aircraft type information in FAEED for long- and medium-range jets and averaging the emission factors. General aviation emission factors were determined using the aircraft type information in FAEED for the five different categories of general aviation: single-engine piston, multi-engine piston, single-engine turboprop, multi-engine turboprop, and helicopters. General military emission estimates were determined as a fleet average using all military aircraft in FAEED except fighter jets. As most of the Luke Air Force Base airport operations are F-16's, those military operation emissions were calculated using FAEED data for F-16's. No emission factors were available for the business jet category, so the air carrier emission factor was used, and these emissions were included under general aviation.

Table 4–2. Aircraft Emission Factors

Aircraft Type (AMS 22-75-050-000)	**Emission Factor (lbs CO/LTO)**
Air Carrier	17.25
Air Taxi	36.32
General Aviation Single-Engine Piston	25.55
General Aviation Single-Engine Turboprop	7.87
General Aviation Multiple-Engine Piston	89.72
General Aviation Multiple-Engine Turboprop	18.92
General Military	83.87
Military F-16s	21.06
Helicopters	5.43

4.2.2 Summary of Aircraft Emissions

The FAEED model was used to generate the emission factors for this inventory. Table 4–3 presents the annual and daily emissions estimated by aircraft type and airport. For calculating general aviation emissions, the percentage of each type of aircraft was estimated from information provided by the airports in the MAG Aviation Air Quality Survey for Airports (MAG, 1994).

Sky Harbor winter activity (October through December) was 26.1% of its total annual activity. Other airport winter activity was calculated according to percentage of fourth quarter activity, which was provided in the surveys. Example calculations follow the table.

Table 4–3. Annual and Season Daily 1999 Aviation Emissions

Airport	Aircraft Type	Annual CO Emissions (tons/yr)	Season Day CO Emissions (lbs/day)
Chandler Municipal Airport	Air Taxi	13.0	73
	General Aviation	1,818.5	10,242
	Military	1.9	11
Deer Valley Airport	General Aviation	2,294.0	13,964
	Military	11.4	70
Glendale Municipal Airport	Air Taxi	10.5	57
	General Aviation	515.0	2,799
Phoenix Goodyear Airport	Air Carrier	4.8	28
	General Aviation	1,076.7	6,156
	Military	2.5	14
Luke Air Force Base	Air Carrier/Taxi	22.6	125
	General Aviation	105.8	587
	Military	799.4	4,432
Mesa Falcon Field Airport	Air Carrier	0.2	1
	Air Taxi	30.1	174
	General Aviation	1,823.6	10,556
	Military	208.2	1,205
Phoenix Sky Harbor	Air Carriers	1,508.2	8,557
	Air Taxi	388.9	2,207
	General Aviation	750.4	4,258
	Military	93.4	530
Scottsdale Airport	Air Taxi	65.6	368
	General Aviation	2,109.6	11,832
	Military	9.6	54
Stellar Aviation	General Aviation	406.4	2,209
Williams Gateway Airport	Air Carriers	4.7	25
	Air Taxi	41.9	223
	General Aviation	2,734.6	14,565
	Military	934.9	4,979
Totals		**17,786.5**	**100,292**

4.2.3 Examples

Example 1: Phoenix Sky Harbor provided operations data for 1999 and aircraft type information from 1998.

Type	1999 Operations
Total Air Carrier	475,627
General Aviation	77,375
Military	4,456

Air taxi and helicopter operations were included with the air carrier operations. The three monthly reports provided by the airport separated out air taxi operations. The average percentage of air taxi operations from these reports was 19%; therefore there are 90,369 air taxi operations. In addition, 7.5%, or 35,672 of reported total air carrier operations are helicopter operations. Unlike the other airports, the information Phoenix Sky Harbor provided was sufficient to create an air carrier aircraft-specific model using FAEED. Results are shown in Appendix 4–2.

For the general aviation category, aircraft type information from the MAG Aviation Survey conducted in 1994 was used to split the category into business jets, single-engine piston, multi-engine piston, single-engine turboprop, and multi-engine turboprop based on percentage of LTOs of each type of aircraft. Operations for 1999 were then further split as follows:

Type	1999 Operations	1999 LTO Cycles
Air Carrier	349,586	174,793
Air Taxi	90,369	45,184
Helicopters	35,672	17,836
General Aviation:	77,375	38,688
–Business Jet	464	232
–Single-engine Piston	57,412	28,706
–Multi-engine Piston	13,618	6,809
–Single-engine Turboprop	0	0
–Multi-engine Turboprop	5,881	2,941
Military	4,456	2,228

4.2.3.1 Phoenix Sky Harbor Air Carrier

Emissions were calculated using the FAEED model by entering data on LTO cycles by aircraft type using 1999 air carrier operations (minus helicopter) and 1998 aircraft type supplied by Phoenix Sky Harbor (Appendix 4–3). The total air carrier emissions calculated by FAEED was 3,794,209 lb/yr. Dividing 349,586 air carrier operations from 439,955 total operations, is 79.5%. Multiplying the total emissions by 79.5%, 3,016,396 lbs/yr are air carrier emissions. Therefore, 20.5% or 777,813 lbs are air taxi emissions. The season day emissions were calculated by multiplying FAEED output by the 26.1% winter seasonal percentage and dividing by 92 days in the season.

Phoenix Sky Harbor Air Carrier Emissions from FAEED

Pollutant	lbs/yr	tons/yr	lbs/season day
CO	3,016,396	1,508.2	8,557

For other airports with air carrier operations, an average emission factor was calculated based on the Phoenix Sky Harbor total air carrier emissions and dividing by LTO cycles:

3,794,209 lb/yr ÷ 219,981 LTOs[3] = 17.25 lb CO/LTO

4.2.3.2 Phoenix Sky Harbor Air Taxi

Air taxi emission factors were calculated from FAEED by averaging all long- and medium-range jets in the database and then dividing by the number of unique engines. Emission factors are shown in Table 4–2. Emissions for all airports except Phoenix Sky Harbor were calculated by multiplying air taxi LTO cycles by the emission factors. As discussed above, Sky Harbor taxi and carrier operations were reported together. Therefore, of the total air carrier emissions calculated by FAEED, 20.5% or 777,813 lbs CO/yr, were air taxi emissions. The season daily emissions were calculated by multiplying the annual emissions by the winter seasonal percentage (26.1% for Phoenix Sky Harbor) and dividing by 92 days in the season.

Phoenix Sky Harbor Air Taxi Emissions from FAEED

Pollutant	lbs/yr	tons/yr	lbs/season day
CO	777,813	388.9	2,207

Emissions for General Aviation included helicopters, and used the emission factors derived from FAEED. Military emissions were calculated using the FAEED emission factor for general military and the reported LTOs.

4.3 Procedure for Estimating Emissions from Locomotives

Chapter 6 of EPA's Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources (EPA, 1992), was followed when estimating locomotive emissions. Railroad operations were separated into three categories: 1) Class I line haul; 2) Class II and Class III line haul; and 3) yard operations. No Class II or Class III line haul (locally operated railroads), were operating within the nonattainment area boundaries of Maricopa County in 1999. Carbon monoxide emissions were calculated from Class I line haul and yard operations data and EPA emission factors (EPA, 1992, Tables 6–1 and 6–2). Total locomotive emissions in the inventory area were calculated by summing the emissions for both categories.

Railroads operating within the nonattainment boundaries of the Maricopa County are:

1) Union Pacific Railroad Company (UP)
Ms. Deb Schafer (402) 271-2358
Room 930
1416 Dodge Street
Omaha, NE 68179

2) Burlington Northern & Santa Fe Railway Company (BNSF)
Mr. John Chavez (909) 386-4082
740 E Carnegie Drive
San Bernardino, CA 92408-3571

4.3.1 Line Haul Locomotives (AMS 22-85-002-005)

Class I line haul locomotives carry mainly interstate freight and most of the passenger service. Emissions are calculated by multiplying the amount of fuel consumed by these locomotives in the inventory area by the appropriate emission factors (EPA, 1992, Table 6–1). UP provided 1999 Gross Tons (GT) and a Fuel Consumption

[3] This number is slightly different from the 219,977 LTOs for air carriers and air taxis due to rounding.

Index for all trains scheduled to operate in the nonattainment area of Maricopa County (Appendix 4–4). The following calculations show how the line haul locomotive emissions were derived.

BNSF provided a Fuel Consumption Index (FCI) of 734 GTM/gal. GTM = Gross Ton Miles.

$$\text{1999 Gal. Diesel per Line Segment} = \frac{\text{GT} \times \text{Length of segment (miles)}}{\text{FCI}}$$

$$= \frac{37{,}570{,}000\ \text{GT} \times 49.0\ \text{miles}}{734\ \text{GTM/gallon}} = 2{,}508{,}079\ \text{gallons diesel/yr}$$

1999 BNSF line haul locomotive emissions are:

Emissions lbs/year = (annual fuel consumption) × (emission factor)

CO lbs/year = (2,508,079 gallons) × (0.0626 lbs/gallon)
= 157,006 lbs/year
= 78.5 tons/year

The Union Pacific Railway Company (UP) determined fuel consumption and calculated emissions following the same method as above. Traffic density and fuel consumption index were provided by UP (Appendix 4–4). The 1999 fuel consumption as reported by UP for line haul locomotives in Maricopa County is calculated as follows:

$$\text{1999 Gallons of Diesel per Line Segment:} = \frac{68{,}380{,}000\ \text{GT} \times 413\ \text{miles}}{722\ \text{GTM/gallon}} = 39{,}114{,}875\ \text{gallons diesel/yr}$$

1999 UP line haul locomotive emissions are:

CO lbs/yr = (39,114,875 gallons) × (0.0626 lbs/gallon)
= 2,448,591 lbs/yr
= 1224.3 tons/yr

Season day emissions were obtained by dividing annual totals by 365. Table 4–5 shows the line haul locomotive estimates by company for both the year and season day in 1999.

Table 4–4. Summary of Annual 1999 Emissions from Class I Line Haul Locomotives

Company	CO tons/yr	CO lbs/day
Union Pacific Railroad Company	1,224.3	6,709
Burlington Northern & Santa Fe Railway Company	78.5	430
Totals	1,302.8	7,139

4.3.2 Yard Locomotives (AMS 22-85-002-010)

Emission calculations for yard locomotives are based on the number of yard/switch locomotives in operation during 1999. Yard/switch locomotives are primarily responsible for moving railcars within a particular railway yard. The national average of annual carbon monoxide emissions per yard locomotive (EPA, 1992) is multiplied by the total number of yard locomotives in operation to calculate emissions in tons per year. UP verified that four yard locomotives operated in 1999. BNSF verified that twelve yard locomotives operated in 1999. Therefore, the total number of yard locomotives in Maricopa County is sixteen. Emission calculations for these sixteen yard locomotives are shown below.

Emissions lbs/year = (# of yard/switch locomotives) × (emission factor lbs/yard locomotive)

$$\text{CO emissions} = 16 \text{ locomotives} \times \frac{7{,}375 \text{ lbs CO}}{\text{locomotive}}$$

$$= 118{,}000 \text{ lbs/yr}$$
$$= 59.0 \text{ tons/yr}$$

Season day emissions were obtained by dividing the annual total by 365.

4.3.3 Summary of Locomotive Emissions

Total annual and season daily emissions from locomotives in the Maricopa County nonattainment area are shown in Table 4–5.

Table 4–5. Summary of 1999 Annual and Season Daily CO Emissions from Locomotives

Locomotive Type	CO (tons/yr)	CO (lbs/day)
Line haul, Class I	1,302.8	7,139
Line haul, Classes II and III	0	0
Yard operations	59.0	323
Total	1,361.8	7,462

4.4 Gasoline and Diesel Nonroad Equipment

Emissions for this category were calculated by growing 1996 emissions data using EPA's Economic Growth Analysis System (E-GAS). These growth factors came from the Economic Growth Analysis System (EGAS), which was developed for the Reasonable Further Progress (RFP) inventory. EGAS, an EPA economic and activity forecast model, provides credible growth factors for developing projected emission inventories. The 1999 annual and average season day emissions listed in Appendix 4–7 for each source category were calculated by multiplying the 1996 calculated emissions with appropriate growth factors. The factors take into account our specific region and county, and required the input of time, from 1996 to 1999. Arizona agricultural statistics were used to develop factors for agricultural equipment. See Appendix 4–8 for growth factors used listed by engine type. The following general equation was used to calculate 1999 emissions:

1999 Emissions = 1996 Emissions × EGAS Growth Factor

Maricopa County Environmental Services Department has taken these emission estimates and made the following modifications:

1. subtracted emissions applied to the nonattainment area from sources that do not operate in Maricopa County (snowmobiles and snowblowers);
2. adjusted the engine type split for 2-stroke vs. 4-stroke lawn mowers;
3. adjusted the seasonal activity for all nonroad equipment.

For some of the nonroad equipment, further adjustments to the emission estimates were applied based on control measures. Oxygenated fuel effects were quantified for gasoline-powered equipment. This was a committed measure of the MAG 1999 Serious Area CO Plan, "Winter Fuel Reformulated Gasoline with 3.5 Percent Oxygen Content November 1 through March 31" (MAG, 1999). MAG ran EPA's CO COMPLEX model, and ascertained a 4.14% reduction in CO emissions from the nonroad gasoline-powered equipment, which was applied to the emissions. Reductions to nonroad emissions based on new diesel engine standards were considered, however these new standards did not affect CO emissions in 1999 (EPA, 1998). The benefit assessment for the non-handheld nonroad engine rule stated that the rule had minimal effect on the CO inventory in nonattainment areas (EPA, 1996). Therefore, no effects were quantified in the 1999 CO emissions inventory for these two rules.

Another adjustment occurred with the 1996 emissions inventory. With respect to lawn mowers, local data collected by ADEQ for use in the REOP showed that the 5% to 95% split between 2-stroke and 4-stroke engines based on the VEOP that was used in the 1996 emissions inventory was inaccurate. In Maricopa County, surveyed residents indicated the split is 15% 2-stroke to 85% 4-stroke (ADEQ, 1997). The 1996 emissions were adjusted to reflect this new split, as the 1996 emissions estimates were the basis for the 1999 emissions.

Seasonal data from NEVES were replaced for all nonroad equipment categories. For agricultural equipment, seasonal percentages were determined using local statistics on crop acreage and tractor activity (Appendix 4–9). The crop acres were obtained from the 1999 Arizona Agricultural Statistics (AASS, 2000). Data on tractor activity for various crops were taken from both the 1993–1994 Arizona Vegetable Crop Budgets (U of A, 1993) and the 1994–1995 Arizona Field Crop Budgets (U of A, 1994) since more recent budgets did not contain the same detailed information. Taking the harvested acres of the principal crops grown in Maricopa County, a weighted seasonal activity average was calculated using monthly tractor activity per acre. This calculation included 271,400 acres of principal crops for which the following equation was used:

$$\%\text{Winter Activity} = \frac{\sum \text{crop acreage} \times (\text{no. of tractor passes/acre per season} \times \text{no. tractor passes/acre per year})}{\text{total crop acreage}}$$

For all nonroad equipment other than agricultural equipment, seasonal percentages were taken from monthly activity fractions listed in the California Air Resources Board (CARB) Documentation of Input Factors for the New Off-road Mobile Source Emissions Inventory Model (EEA, 1992). The activity levels are provided in Appendix 4–10. MCESD chose to use these seasonal percentages because they more closely resemble the limited data available for Maricopa County. For example, the CARB seasonal percentage of lawn and garden equipment activity for the winter season is 19.1%. In comparison, the NEVES study indicates that only 6% of the lawn and garden activity occur in the winter based on an analysis of agricultural activity from areas of the country of quite different climates. The following equation was used to adjust emissions to the new seasonal activity levels.

$$\text{Emissions\_new} = (\text{Emissions\_old} \times 0.191) / 0.06$$

where: Emissions_old = 1990 NEVES emissions estimates using 6% season adjustment

Emissions_new = 1990 NEVES emissions estimates using 19.1% season adjustment.

This seasonal adjustment was applied to all engines in the NEVES lawn and garden category. The emission estimates for nonroad equipment are listed in Tables 4–6.

Table 4–6. Summary of all Nonroad Equipment Emissions Within the Nonattainment Area

Type of Equipment	CO tons/yr	CO tons/day
Diesel	13,956.1	37.64
4-Stroke Gasoline	143,377.2	425.85
2-Stroke Gasoline	18,560.6	56.58
Totals	175,893.8	520.07

4.5 Summary of All Nonroad Mobile Source Emissions

Table 4-7 provides a summary of all nonroad mobile source emissions.

Table 4–7. Summary of all Nonroad Mobile Source Emissions

Type of Equipment	CO tons/yr	CO lbs/day
Aircraft Activity	17,786	100,292
Locomotives	1,362	7,462
Nonroad Equipment	175,894	1,040,140
Totals	195,042	1,147,894

4.6 References for Section 4

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SECTION 5. ONROAD MOBILE SOURCES

5.1 Introduction

The Maricopa Association of Governments (MAG) prepared the onroad mobile source emission estimates for the 1999 Periodic Carbon Monoxide Inventory for the Maricopa County Nonattainment Area. This documentation is divided into nine subsections: Introduction, VMT Estimation Procedure, Speed Estimation Procedure, CO Season VMT Factor, Emission Factor Estimation Procedure, Summary of CO Emissions From Onroad Mobile Sources, Quality Assurance Process, References, and Appendices.

Onroad mobile source emission estimates have been calculated for carbon monoxide (CO) for the 1999 Periodic CO Inventory. These onroad mobile source estimates are for the 1872 square-mile CO nonattainment area within Maricopa County. Emission estimates were calculated for the following vehicle types: light duty gas vehicles (LDGV), light duty gas truck of gross vehicle weight under 6000 pounds (LDGT1) or over 6000 pounds (LDGT2), heavy duty gas vehicles (HDGV), light duty diesel vehicles and trucks (LDDV and LDDT), heavy duty diesel vehicles (HDDV), and motorcycles (MC). Emission factors for these vehicle types were calculated using MOBILE5a, the current version in a series of models developed by the U.S. Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors. The resulting emission factors were multiplied by the estimates of vehicle miles of travel (VMT) to generate emission estimates.

5.2 VMT Estimation Procedure

MAG prepared the 1999 vehicle miles of travel (VMT) estimates for the carbon monoxide nonattainment area. The source of data for these estimates is the revised 1999 Highway Performance Monitoring System (HPMS) data (see Appendix 5-1) submitted to the U.S. Department of Transportation, Federal Highway Administration (FHWA) by the Arizona Department of Transportation (ADOT) in April 2001. ADOT initially submitted 1999 HPMS data to FHWA in August 2000. A revised version, incorporating improved traffic counts on the state highway system, was submitted in April 2001. The contact person for the VMT estimates is Cathy Arthur (602-254-6300).

Each year, MAG coordinates the collection of HPMS data, including the annual average daily traffic (AADT) estimates for HPMS sample sections which are utilized to develop HPMS VMT estimates. ADOT provides the AADT for the state highway system routes including interstates, urban freeways, and principal arterials in Maricopa County. ADOT merges the Maricopa County data with information from other Arizona counties to create the statewide HPMS data set submitted to FHWA each year.

Arizona's HPMS database file contains a number of data elements that describe general roadway characteristics and use for every non-local roadway within the state. All non-local roadways have been divided into section records that are 0.3 to 10 miles in length, in accordance with HPMS criteria. Such roadway segments are called HPMS "universe" section records. HPMS contains additional data elements that provide more detailed operational and performance information on a randomly-selected subset of the file's 10,000+ universe records. These more detailed records containing additional highway attributes are known as "sample panels" or "sample sections." The VMT estimates which ADOT submits to FHWA each year are generated from HPMS universe data for all interstates, urban freeways, and principal arterials. Sample section data are expanded to estimate VMT on all other non-local systems.

VMT on local streets in the urbanized portion of the modeling area is estimated using traffic counts collected on 50 randomly-selected local streets in June-July of 1994. These counts resulted in an AADT of 587 for local roads in the urbanized area. To calculate VMT, this AADT was applied to local road mileage in 1994 obtained from the Maricopa County street centerline coverage. In 1994, an AADT of 150 was assumed for local roads which are inside the PM-10 (particulates of size ten microns or less) nonattainment area, but outside the urbanized area boundary. Since 1994, the AADTs on local streets have been increased annually on the basis of the rate of population growth in Maricopa County; the number of center line miles of local streets is updated annually by the local jurisdictions in Maricopa County. VMT for the CO nonattainment area, based on the revised 1999 HPMS data ADOT submitted to FHWA in April 2001, is summarized by area type and facility type in Table 5-1. Area types are a function of population and employment density as described in Table 5-1. Facility types represent the characterizations of different roadway types such as capacity, design, and purpose (i.e. serving regional or neighborhood traffic).

The revised 1999 HPMS System Length and Daily Vehicle Travel for Individual Urbanized Areas (in Appendix 5-1) was submitted to FHWA by ADOT in April 2001. This table reported a 1999 average daily VMT for the Phoenix urbanized area of 55.072 million. In comparison, the 1999 urbanized area VMT for the CO nonattainment area used in the periodic emissions inventory is 54.521 million. The one percent difference between these estimates is attributable to small sections of the Phoenix urbanized area (i.e. Apache Junction) which are not located in the CO nonattainment area. The HPMS System Length and Daily Travel, Donut Area Data for Individual NAAQS Nonattainment Areas, (in Appendix 5-1), reported a revised 1999 VMT for the "donut" area of 5.174 million. The "donut" area is an HPMS term referring to the area inside the PM-10 nonattainment area, but outside the Phoenix urbanized area boundary. The VMT for the CO nonattainment area is 72 percent of the HPMS "donut" area VMT or 3.725 million. The factors (i.e. 99 percent for the urbanized area and 72 percent for the donut area) used to determine the allocation of HPMS VMT to the CO nonattainment area were derived from the report, Maricopa Association of Governments Highway Performance Monitoring System Update, January 1995. These same factors were also used to derive VMT for the CO tracking area in Chapter Three of the MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, June 1999. It is important to note that the 1999 HPMS daily VMT for the CO nonattainment area is within one percent of the 1999 VMT estimated by the

MAG travel demand models for the Serious Area CO Plan. The total 1999 daily VMT for the urbanized and "donut" areas in the CO nonattainment area is 58.247 million, as shown in Table 5-1.

The VMT by facility type in Table 5-1 was derived from the 1999 HPMS data, while the distribution by area type was derived from 1998 traffic counts. These counts were assigned to a 1998 highway network using MAG travel demand models. The output of this assignment was evaluated using Geographic Information Systems (GIS) to obtain VMT by area type and facility type for the Phoenix urbanized and "donut" areas. The area type distributions from the MAG traffic assignment were applied to the 1999 HPMS VMT estimates by facility type for the urbanized and "donut" areas to create Table 5-1.

Although HPMS includes vehicle mix data for urban and rural areas of Arizona, there are insufficient classification stations in the Phoenix urbanized area to justify use of this information in calculating VMT by vehicle class. In addition, the HPMS vehicle class data do not discriminate between gas and diesel vehicles. Therefore, MOBILE5a model defaults, representing the fraction of total VMT for each vehicle class, were applied to VMT estimates for each facility type and area type in Table 5-1.

Table 5–1. 1999 HPMS VMT by Area and Facility Type for the CO/Ozone Nonattainment Area (Annual Average Daily Traffic)

	AREA TYPE *					
Facility Type	**1**	**2**	**3**	**4**	**5**	**Total**
Interstate/Freeway	1,277,694	8,275,357	5,740,120	2,197,672	686,975	18,177,818
Principal Arterial / Minor Arterial	509,464	9,637,550	10,924,791	5,331,263	2,272,805	28,675,873
Collector	261,621	2,943,882	1,374,465	652,983	823,809	6,056,760
Local	59,642	1,823,506	2,191,031	1,088,309	173,623	5,336,111
Total:	2,108,421	22,680,295	20,230,407	9,270,227	3,957,212	58,246,562

* Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

** Collectors are minor streets that connect a neighborhood to a half-mile or mile arterial.

5.3 Speed Estimation Procedure

MAG prepared the average daily speeds for the 1999 periodic carbon monoxide emissions inventory. The average daily speeds were obtained from an EXPLORA emissions model run for 1999. EXPLORA integrates travel demand modeling output and FORTRAN-based emissions processing programs into a planning tool that may be applied at the subregional or regional level to examine transportation and related air quality issues.

The peak and off-peak speeds used in the EXPLORA volume to capacity (V/C) versus speed table were derived from the MAG study, 1993 Study of Travel Speed and Delay in the MAG Region, January 1995. The peak and off-peak speeds obtained from this study were coded into the link records for each road or street segment for which speed data were collected. A program called SPDVAL was then run to obtain the peak and off-peak speeds by area type and facility type. Freeways and arterials were the only two facility types with a sufficient sample size to obtain speeds by area type.

These peak and off-peak freeway and arterial speeds were used to revise the EXPLORA V/C versus speed table. Speeds for other minor facility types were derived from the MAG study, 1986 Phoenix Urbanized Area Travel Speed Study, October 1986. MAG plans to conduct a new speed study in FY 2002. It is anticipated that the results of this speed study will be incorporated into the next periodic inventory analysis.

1999 link-based traffic volumes and capacities output by the MAG travel demand model were input to EXPLORA to obtain average daily speeds by area type and facility type. The final speeds used in constructing the 1999 periodic emissions inventory are presented in Table 5-2.

Table 5–2. Average Daily Speeds For the 1999 Periodic Emissions Inventory (in mph)

	AREA TYPE *				
Facility Type	**1**	**2**	**3**	**4**	**5**
Interstate/Freeway	52.1	6.8	57.1	61.3	63.3
Principal Arterial / Minor Arterial	27.0	28.0	30.4	33.8	42.0
Collector	24.0	24.3	25.6	28.1	27.7
Local	15.0	20.0	5.0	25.0	30.0

*Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

5.4 CO Season VMT Factor

The Maricopa Association of Governments (MAG) developed the CO season VMT factor for the carbon monoxide periodic emission inventory. Since the VMT utilized in the periodic emissions inventory is based on annual average daily traffic (AADT), it is necessary to examine the relationship between AADT and monthly traffic variations and correct for any differences.

The carbon monoxide season for the Maricopa County nonattainment area occurs from October through April. The peak CO season reflects the three consecutive months when peak CO concentrations occur. For consistency with the 1996 Base Year Carbon Monoxide Inventory, the three consecutive months selected were November 1999 through January 2000, in accordance with EPA guidance.

The CO season VMT factor was developed from 1993 automated traffic recorder (ATR) data collected at five sites located in the CO nonattainment area. Although there were eight active ATRs, only five collected twelve months of continuous data in 1993. The 1993 traffic count factors for the winter months for each ATR are provided below. These represent the ratio of the average monthly counts to the annual average counts.

Traffic Count Factors by Month

	November	December	January
ATR 24 - Grand Ave @ Glendale Ave	0.99555	0.95513	0.99076
ATR 30 - Indian School @ 47th Dr	0.96552	1.03016	1.00377
ATR 31 - Central Ave @ Montebello	1.02748	1.01715	0.93712
ATR 32 - Lincoln Dr @ 23rd St	1.01324	1.02714	0.97627
ATR 34 - Squaw Peak Pkwy @ Crittendon	1.01396	0.99365	0.95205
Averages:	1.00315	1.00465	0.97199

The average (arithmetic mean) of the monthly factors across all five stations is 0.99326. When this factor is applied, the resultant 1999 average daily VMT by facility type for the CO season is illustrated in Table 5-3. Although shopping trips increase during November and December, the reduction in work and school trips during the holidays more than offset this increase.

Table 5–3. Average Daily VMT During 1999 Carbon Monoxide Season (November 1999–January 2000)

	Area Type *					
Facility Type	**1**	**2**	**3**	**4**	**5**	**Total**
Interstate/Freeway	1,269,082	8,219,581	5,701,432	2,182,860	682,345	18,055,300
Principal Arterial / Minor Arterial	506,030	9,572,593	10,851,158	5,295,330	2,257,486	28,482,598
Collector	259,858	2,924,040	1,365,201	648,582	818,257	6,015,937
Local	59,240	1,811,216	2,176,263	1,080,974	172,453	5,300,146
Total:	2,094,210	22,527,430	20,094,054	9,207,746	3,930,540	57,853,980

* Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

5.5 Emission Factor Estimation Procedure

5.5.1 Emission Factor Model

CO vehicle exhaust emission factors were calculated using MOBILE5a. MOBILE5a is a current version in a series of models developed by EPA for the purpose of estimating motor vehicle emission factors for carbon monoxide. The resulting emission factors were combined with VMT estimates to produce emission estimates for carbon monoxide. The MOBILE5a runs were executed by the Maricopa Association of Governments. The contact person for the MOBILE5a emission estimates is Roger Roy (602-254-6300).

The following three MOBILE5a runs were executed for carbon monoxide for a typical day (24-hour period) during the three-month period of November through January:

1. Enhanced inspection/maintenance (I/M240) program in place with no exemption for current +4 model year vehicles. For the purposes of this analysis, the current +4 model years reflect the current model (2000) and the previous four model years (1996-1999).

2. I/M240 program with exemption for current +4 model year vehicles.

3. No I/M program in place.

The emission factors estimated with these runs were combined to reflect the actual proportions of vehicles subject to the specified levels of inspection. The term "I/M vehicles" denotes vehicles which are required to undergo an emission test and/or inspection under the Arizona Vehicle Inspection/Maintenance Program. It is important to note that participation in the I/M program is required for all vehicles *registered* in the nonattainment area, with the exception of certain model year and vehicle types. However, it is assumed that of the vehicles which are of an age and type subject to an I/M program only 91.7 percent of the vehicles *operating* within the nonattainment area participate in the I/M program. The remaining 8.3 percent do not participate in the program. These percentages reflect the implementation of the control measures "Tougher Registration Enforcement" and "Expansion of Area A Boundaries", described in the MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, MAG, June 1999. In the absence of any additional data, this percentage split is assumed to apply directly to VMT as well. Specifically, the base fraction of vehicles participating in the I/M program in the Serious Area CO Plan (89.6 percent) is increased by 2.0 percent reflecting the full implementation of "Tougher Registration Enforcement" and by 0.1 percent reflecting partial implementation of "Expansion of Area A".

In order to accurately reflect the state of the I/M program in the modeling area, several MOBILE5a runs were performed and the emission factors from those runs were weighted together. Two MOBILE5a runs which reflected I/M and one which reflected no I/M were performed. The weighting of one I/M and one non-I/M run is explained in the previous paragraph. The weighting of *two* I/M runs is the result of a limitation to the MOBILE5a model. MOBILE5a does not accurately model a change in the variable "last model year tested" if the change in the "last model year tested" value occurred within the current I/M cycle.

This limitation is relevant because the current +4 model year vehicles were exempted from the I/M program beginning in August 1998. This modeling effort reflects the three-month period of November 1999 through January 2000. During the middle of these three months, December 1999, the exemption of current +4 vehicles from testing had been implemented 16 months earlier in the current 24-month cycle. For this reason, the change had effectively propagated through two-thirds (16 months/24 months) of the I/M240 fleet. The exemption of the recent model years was modeled through a weighting of two MOBILE5a runs, one reflecting the exemption of the current +4 model years (in this case, model years 1996-2000) and one which did not include that exemption.

Refer to Appendix 5-2 for portions of the actual input and output files and a spreadsheet showing the emission factor calculations.

5.5.2 Development of Model Inputs

The inputs to MOBILE5a are grouped into eight categories: Control Section, I/M Descriptive Input, Alternative I/M Credit Files, ATP Descriptive Input, Pressure Test Descriptive Input, Scenario Records, Local Area Parameter, and Oxygenated Fuels Descriptive Record. The input values used in the above described MOBILE5a runs are specified and explained below.

5.5.2.1 Control Section

1. TAMFLG=1 indicates that MOBILE5a default tampering rates were used as recommended in the User's Guide.

2. SPDFLG=1 indicates that user-supplied speeds were applied to all vehicle types. *Refer to item 3 in the Scenario Records section for development of input.*

3. VMFLAG=1 indicates that MOBILE5a default VMT mix (national average) was used; this is due to the difficulty in obtaining accurate mileage accumulation rates by vehicle class. This parameter specifies the fraction of total VMT that is accumulated by each of the eight vehicle classes.

4. MYMFLG=3 indicates that user supplied registration distributions and MOBILE5a annual mileage accumulation rates were used, as recommended by the User's Guide. The vehicle registration distributions incorporated into this analysis are derived from registration data for 1999 provided by the Arizona Department of Transportation.

5. NEWFLG=1 indicates that MOBILE5a default basic exhaust rates were used, as recommended by the User's Guide.

6. IMFLAG=1 and 3 means that one of two flags was set in the three MOBILE5a runs that were executed. Two runs assumed that two I/M programs were in place, and the other run assumed that no I/M program was in place. The emission factors obtained from the runs were then weighted together.

7. ALHFLG=1 indicates that no additional correction factors were input. Correction factors were not required per the User's Guide.

8. ATPFLG=1 or 5 were input to indicate that one run involved no anti-tampering program and no pressure test and two runs included both an anti-tampering program and pressure test.

9. RLFLAG=5 indicates that refueling emissions were zeroed-out. Refueling emissions do not contribute to CO emissions.

10. LOCFLG=1 indicates that a separate Local Area Parameter (LAP) record was entered for each scenario of the MOBILE5a runs. The area type for which emission factors were being calculated was specified within each LAP record.

11. TEMFLG=1 indicates that MOBILE5a internally calculated the temperatures to be used in the correction of emission factors based upon the minimum and maximum daily temperatures provided in the LAP record. This option is recommended by the Users' Guide. Note: The ambient temperature input within each scenario record is overridden by the temperature internally calculated by the model.

12. OUTFMT=6 means outputs were in a spreadsheet format to facilitate subsequent calculations.

13. PRTFLG=2 indicates that calculations were performed for CO emission factors only.

14. IDLFLG=1 indicates that no idle emission factors were calculated. Idle emission factors are not necessary for this inventory.

15. NMHFLG=4; note: this flag is not applicable for carbon monoxide runs.

16. HCFLAG=3; note: this flag is not applicable for carbon monoxide runs.

5.5.2.2 I/M Descriptive Input Record

The I/M240 inputs used for the 1999 periodic inventory are consistent with those used for the projected modeling inventory in the Serious Area CO plan for the 2000 base case (MAG, 1999) with minor adjustments made to the waiver rates and last model year tested.

1. PROGRAM START YEAR=77

2. STRINGENCY LEVEL=28% indicates that 28 percent of pre-1981 model year passenger cars or pre-1984 light duty trucks are expected to fail the initial I/M test in a given testing cycle.

3. FIRST MODEL YEAR=67 or 81 for the basic I/M or I/M240 program.

4. LAST MODEL YEAR=20 or 95

5. WAIVER RATE for PRE-1981 MODEL YEAR VEHICLES=1% indicates that one percent of pre-1981 model year vehicles which fail the initial I/M test will receive a waiver.

6. WAIVER RATE for 1981 and LATER MODEL YEAR VEHICLES=2% indicates that two percent of 1981 and later model year vehicles which fail the initial I/M test will receive a waiver.

7. COMPLIANCE RATE=97% indicates that 97 percent of the vehicles registered in the modeling area complete the I/M process to the point of either passing the I/M test or receiving a valid waiver.

8. PROGRAM TYPE=1 for centralized program.

9. INSPECTION FREQUENCY=1 or 2 for annual inspection frequency for the basic I/M or biennial frequency for the I/M240 program.

10. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2222 or 2221 indicates that LDGV, LDGT1, LDGT2, and HDGV are all subject to inspection for the basic I/M program but that HDGVs are exempt from the I/M240 program.

11. TEST TYPE=3 or 4 for a loaded idle basic I/M test or a transient I/M240 test.

12. CUTPOINTS=1 or 2 indicates that MOBILE5a default cutpoints were used for the basic I/M program but that non-default cutpoints were used for the I/M240 test.

13. ALTERNATE I/M CREDITS INPUT BY USER=11 or 22 indicates that MOBILE5a default credits were used for Tech I-II and Tech IV+ vehicles for the basic I/M program but that alternate I/M credits were used for the I/M240 program.

14. USER SUPPLIED CUTPOINTS=2.00 30.0 3.00 indicates the cutpoints in grams per mile chosen for HC, CO, and NOx respectively. These cutpoints are used only for the enhanced I/M240 program.

5.5.2.3 Alternative I/M Credit Files

Since the I/M240 cutpoints in use in the nonattainment area are not a standard set of cutpoints built into the MOBILE5a program, an alternative set of cutpoints was developed by Radian International for use in onroad modeling. These alternative cutpoint credit files were further adjusted by MAG using the EPA Remote Sensing Utility to account for the implementation of a remote sensing program, which was still in place during the period modeled. A remote sensing program is a form of vehicle emissions inspection which measures instantaneous vehicle emissions during actual driving conditions. The credit files listed below are in ASCII format and contain a very large and nondescript array of numbers used to apply emissions reductions credits.

TECH I-II VEHICLES CREDIT FILE= f:\mobile5a\tech12.1me

TECH IV+ VEHICLES CREDIT FILE= f:\mobile5a\imdata.1me

5.5.2.4 ATP Descriptive Input Record

The anti-tampering program (ATP) inputs are consistent with those used for the base case Serious Area CO SIP inventory for 2000.

1. PROGRAM START YEAR=87 indicates that the ATP program began in 1987.
2. FIRST MODEL YEAR=75 indicates that the ATP program includes vehicles of model year 1975 and later.
3. LAST MODEL YEAR=80 indicates that vehicles of model year 1981+ are exempt from the ATP program because they are subject to the I/M240 program.
4. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2222 indicates that LDGV, LDGT1, LDGT2 and HDGV are all subject to inspection.
5. PROGRAM TYPE=1 for centralized program.
6. INSPECTION FREQUENCY=1 for annual inspection frequency.
7. COMPLIANCE RATE=97%
8. INSPECTIONS PERFORMED=22111222 indicates that the following ATP inspections are performed: air pump system, catalyst, evaporative control system, PCV system, and gas cap tests; and that the EGR system, fuel inlet restrictor, and tailpipe lead deposit tests are not performed.

5.5.2.5 Pressure Test Descriptive Input Record

The pressure test inputs are consistent with those used for the base case Serious Area CO SIP inventory for 2000.

1. PROGRAM START YEAR=96 indicates that the pressure test began in 1996.
2. FIRST MODEL YEAR=81 indicates that the pressure test includes vehicles of model year 1981 and later.

3. LAST MODEL YEAR=20 or 95

4. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2221 indicates that LDGV, LDGT1, and LDGT2 are all subject to inspection. HDGV are exempt from the pressure test.

5. PROGRAM TYPE=1 for centralized program.

6. INSPECTION FREQUENCY=2 for biennial inspection frequency.

7. COMPLIANCE RATE=97%

5.5.2.6 Scenario Records

1. REGION=1 indicates the geographic area modeled was low altitude.

2. CALENDAR YEAR=00; was input because the applicable three-month period for this inventory is November, December, 1999 and January, 2000. To be consistent with the User's Guide, the calendar year 2000 was chosen to model conditions representative of the applicable period.

3. SPEED; a scenario utilizing the speed for each combination of facility and area type was executed (see Table 5-2). Speed values were input for interstates/freeways, principal/minor arterials, collectors, and local roads. These speed values were derived from the 1993 Study of Travel Speed and Delay in the MAG Region.

4. AMBIENT TEMPERATURE= 63.7 degrees Fahrenheit; the ambient temperature was calculated from data provided by MCESD (see Appendix 5-3) in accordance with the temperature guidance and input in each scenario. It is important to note that this temperature is not actually utilized by the model due to TEMFLG=1. Refer to item 11 in the Control Section for additional information.

5. OPERATING MODES=20.6, 27.3, 20.6; the MOBILE5a (FTP) standard operating mode fractions were used as recommended by the User's Guide. These values represent percent cold-start/non-catalyst VMT (PCCN), percent cold-start/catalyst VMT (PCCC), and percent hot-start/catalyst VMT (PCHC) respectively. The other relevant operating mode conditions of stabilized/catalyst VMT, stabilized/non-catalyst VMT, and hot-start/non-catalyst VMT are derived internally by MOBILE5a using PCCN, PCCC, PCHC.

6. MONTH OF EVALUATION=Blank indicates that January was the month being evaluated.

5.5.2.7 Local Area Parameter Record

1. SCENARIO NAME; An area type and facility type were indicated for each scenario (speed).

2. ASTM VOLATILITY CLASS was left blank because the RFGFLG (Item 8 below) was set to indicate no reformulated gasoline. Rather, actual monitored fuel data for the modeling period was input to the model, as described in number eight.

3. MINIMUM and MAXIMUM DAILY TEMPERATURE=45 and 73 degrees Fahrenheit; for consistency, the same daily minimum and maximum temperatures used in preparing the 1990 Base Year CO Inventory were also used for the 1999 periodic inventory. The temperatures were calculated by the Maricopa County Environmental Services Department (MCESD) using EPA-recommended procedures (see Appendix 5-3).

4. "PERIOD 1" RVP= 8.43; to determine these inputs, RVP data were obtained from the Arizona Department of Weights and Measures for the applicable period (see Appendix 5-4).

5. "PERIOD 2" RVP = 8.43; the RVP for period 2 is the same as for period 1, with a start year of 2020. The period 2 RVP is in effect being dummied out because only one calendar year is being modeled.

6. OXYFLG=2 indicates the effects of oxygenated fuels were modeled in order to represent actual conditions that existed in the applicable period.

DSFLAG=2 indicates that locally derived diesel sales fractions were used. The diesel sales fractions immediately follow the Oxygenated Fuels Descriptive Records.

RFGFLG was left blank, indicating that the reformulated gasoline flag was set to indicate no reformulated gasoline. Rather than permitting MOBILE5a to set the local gasoline RVP and oxygenate content to reflect default values for Federal RFG, measured gasoline RVP and oxygenate data, provided by the Arizona Department of Weights and Measures for the appropriate time period, were input to MOBILE5a.

5.5.2.8 Oxygenated Fuels Descriptive Record

1. MTBE BLEND MARKET SHARE= 0%; The MTBE market share fraction for the applicable period was obtained from the Arizona Department of Weights and Measures.

2. ALCOHOL BLEND MARKET SHARE=100%; The ethanol market share fraction for the applicable period was obtained from the Arizona Department of Weights and Measures.

3. AVERAGE OXYGEN CONTENT OF ETHER BLEND FUELS=0.0%; to determine this input, testing data were obtained from the Arizona Department of Weights and Measures for the applicable period (see Appendix 5-4).

4. AVERAGE OXYGEN CONTENT OF ALCOHOL BLEND FUELS=3.4%; to determine this input, testing data were obtained from the Arizona Department of Weights and Measures for the applicable period (see

Appendix 5-4). Note that these data do not reflect the entire CO season, but only the period considered in this modeling effort, November 1999 through January 2000.

5. RVP WAIVER SWITCH=1 indicating a 1 psi exemption was not utilized. This is because actual RVP data was input to the model.

5.5.3 Model Outputs

MOBILE5a was executed with the inputs described above to obtain composite emission factors in grams per mile (g/mi) for exhaust CO. These values were obtained for the eight vehicle classes described in the Introduction for the various speeds as described in item three of the Scenario Records section. The emission factors generated for the 1999 carbon monoxide season are presented in the following section. Representative output runs are contained in Appendix 5-2. These values were subsequently used in developing emission estimates.

5.5.5 Summary of Emission Factors

Refer to Appendix 5-2 for the emission factors developed for CO for each facility and area type.

5.5.6 Emission Estimates

MOBILE5a was used to generate CO emission factors for vehicle class, facility, and area type. Daily VMT for the CO season (Table 5-3) was then multiplied by the VMT mix by vehicle class and the appropriate CO emission factor (Appendix 5-2) to estimate CO emissions on a kilogram per day (kg/day) basis. An example calculation is given below:

$$\underset{\text{(DVMT)}}{700{,}491} \times \underset{\text{(VMT Mix)}}{0.634} \times \underset{\text{(CO Emission Factor, in g/mi)}}{7.609} \div \underset{\text{(grams / kg)}}{1{,}000} = \underset{\text{(CO emissions in kg/day)}}{3{,}379}$$

$$\underset{\text{(CO emissions in kg/day)}}{3{,}379} \times \frac{1\text{ lb}}{0.4536\text{ kg}} = \underset{\text{(CO emissions in lbs/day)}}{7{,}449}$$

Table 5-4 shows daily VMT data, associated speed estimates, MOBILE5a emission factors, and the calculated onroad emissions for each vehicle class, facility type, and area type.

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
INTERSTATE, FREEWAY, & EXPRESSWAY	LDGV with VMT mix of 60.5%	1	52.1	4.611	1,269,082	7,800.0	3,538.1
		2	56.8	5.572	8,219,581	61,042.9	27,689.1
		3	57.1	5.732	5,701,432	43,557.3	19,757.6
		4	61.3	7.973	2,182,860	23,197.6	10,522.5
		5	63.3	9.040	682,345	8,221.8	3,729.4
	LDGT1 with VMT mix of 17.6%	1	52.1	6.352	1,269,082	3,130.9	1,420.2
		2	56.8	7.836	8,219,581	25,016.3	11,347.4
		3	57.1	8.084	5,701,432	17,900.7	8,119.8
		4	61.3	11.546	2,182,860	9,789.1	4,440.3
		5	63.3	13.196	682,345	3,497.1	1,586.3
	LDGT2 with VMT mix of 8.6%	1	52.1	7.705	1,269,082	1,855.8	841.8
		2	56.8	9.708	8,219,581	15,143.9	6,869.3
		3	57.1	10.041	5,701,432	10,865.1	4,928.4
		4	61.3	14.714	2,182,860	6,095.4	2,764.9
		5	63.3	16.939	682,345	2,193.6	995.0
	HDGV with VMT mix of 3.8%	1	52.1	11.947	1,269,082	1,271.5	576.7
		2	56.8	13.236	8,219,581	9,123.2	4,138.3
		3	57.1	13.344	5,701,432	6,380.0	2,894.0
		4	61.3	15.279	2,182,860	2,796.9	1,268.7
		5	63.3	16.521	682,345	945.3	428.8
	LDDV with VMT mix of 0.2%	1	52.1	0.751	1,269,082	4.2	1.9
		2	56.8	0.791	8,219,581	28.7	13.0
		3	57.1	0.795	5,701,432	20.0	9.1
		4	61.3	0.863	2,182,860	8.3	3.8
		5	63.3	0.908	682,345	2.7	1.2
	LDDT with VMT mix of 1.4%	1	52.1	0.724	1,269,082	28.4	12.9
		2	56.8	0.763	8,219,581	193.8	87.9
		3	57.1	0.766	5,701,432	134.9	61.2
		4	61.3	0.833	2,182,860	56.2	25.5
		5	63.3	0.876	682,345	18.5	8.4
	HDDV with VMT mix of 7.4%	1	52.1	5.334	1,269,082	1,105.4	501.4
		2	56.8	5.620	8,219,581	7,543.6	3,421.8
		3	57.1	5.646	5,701,432	5,256.8	2,384.5
		4	61.3	6.134	2,182,860	2,186.6	991.8
		5	63.3	6.454	682,345	719.2	326.2
	MC with VMT mix of 0.5%	1	52.1	7.126	1,269,082	99.8	45.3
		2	56.8	10.215	8,219,581	926.4	420.2
		3	57.1	10.730	5,701,432	675.0	306.2
		4	61.3	17.937	2,182,860	432.0	196.0
		5	63.3	21.369	682,345	160.9	73.0

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
PRINCIPAL ARTERIALS & MINOR ARTERIALS	LDGV with VMT mix of 60.5%	1	27.0	8.768	506,030	5,914.2	2,682.7
		2	28.0	8.426	9,572,593	107,511.5	48,767.2
		3	30.4	7.694	10,851,158	111,284.5	50,478.7
		4	33.8	6.836	5,295,330	48,247.2	21,884.9
		5	42.0	5.354	2,257,486	16,111.6	7,308.2
	LDGT1 with VMT mix of 17.6%	1	27.0	11.062	506,030	2,174.2	986.2
		2	28.0	10.668	9,572,593	39,663.0	17,991.2
		3	30.4	9.825	10,851,158	41,406.6	18,782.0
		4	33.8	8.834	5,295,330	18,168.8	8,241.3
		5	42.0	7.156	2,257,486	6,274.8	2,846.2
	LDGT2 with VMT mix of 8.6%	1	27.0	13.358	506,030	1,282.8	581.9
		2	28.0	12.886	9,572,593	23,409.5	10,618.5
		3	30.4	11.875	10,851,158	24,454.8	11,092.7
		4	33.8	10.688	5,295,330	10,740.9	4,872.1
		5	42.0	8.673	2,257,486	3,715.6	1,685.4
	HDGV with VMT mix of 3.8%	1	27.0	15.742	506,030	668.0	303.0
		2	28.0	15.163	9,572,593	12,172.0	5,521.2
		3	30.4	13.983	10,851,158	12,724.0	5,771.6
		4	33.8	12.740	5,295,330	5,657.2	2,566.1
		5	42.0	11.301	2,257,486	2,139.3	970.4
	LDDV with VMT mix of 0.2%	1	27.0	1.122	506,030	2.5	1.1
		2	28.0	1.080	9,572,593	45.6	20.7
		3	30.4	0.994	10,851,158	47.6	21.6
		4	33.8	0.899	5,295,330	21.0	9.5
		5	42.0	0.769	2,257,486	7.7	3.5
	LDDT with VMT mix of 1.4%	1	27.0	1.082	506,030	16.9	7.7
		2	28.0	1.042	9,572,593	308.2	139.8
		3	30.4	0.958	10,851,158	321.2	145.7
		4	33.8	0.867	5,295,330	141.8	64.3
		5	42.0	0.742	2,257,486	51.8	23.5
	HDDV with VMT mix of 7.4%	1	27.0	7.974	506,030	658.9	298.9
		2	28.0	7.677	9,572,593	12,000.9	5,443.6
		3	30.4	7.061	10,851,158	12,512.3	5,675.6
		4	33.8	6.385	5,295,330	5,521.4	2,504.5
		5	42.0	5.463	2,257,486	2,014.0	913.5
	MC with VMT mix of 0.5%	1	27.0	13.083	506,030	73.0	33.1
		2	28.0	12.562	9,572,593	1,326.8	601.9
		3	30.4	11.428	10,851,158	1,368.3	620.7
		4	33.8	10.077	5,295,330	588.8	267.1
		5	42.0	7.931	2,257,486	197.6	89.6

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
COLLECTOR	LDGV with VMT mix of 60.5%	1	24.0	9.963	259,858	3,450.8	1,565.3
		2	24.3	9.830	2,924,040	38,313.8	17,379.1
		3	25.6	9.292	1,365,201	16,909.0	7,669.9
		4	28.1	8.393	648,582	7,256.0	3,291.3
		5	27.7	8.526	818,257	9,299.0	4,218.0
	LDGT1 with VMT mix of 17.6%	1	24.0	12.427	259,858	1,254.2	568.9
		2	24.3	12.277	2,924,040	13,942.5	6,324.3
		3	25.6	11.662	1,365,201	6,183.4	2,804.8
		4	28.1	10.630	648,582	2,677.9	1,214.7
		5	27.7	10.784	818,257	3,427.2	1,554.6
	LDGT2 with VMT mix of 8.6%	1	24.0	14.997	259,858	739.6	335.5
		2	24.3	14.816	2,924,040	8,221.9	3,729.5
		3	25.6	14.077	1,365,201	3,647.3	1,654.4
		4	28.1	12.840	648,582	1,580.5	716.9
		5	27.7	13.024	818,257	2,022.5	917.4
	HDGV with VMT mix of 3.8%	1	24.0	17.851	259,858	389.0	176.4
		2	24.3	17.612	2,924,040	4,318.6	1,958.9
		3	25.6	16.652	1,365,201	1,906.4	864.8
		4	28.1	15.108	648,582	821.7	372.7
		5	27.7	15.331	818,257	1,052.0	477.2
	LDDV with VMT mix of 0.2%	1	24.0	1.271	259,858	1.5	0.7
		2	24.3	1.255	2,924,040	16.2	7.3
		3	25.6	1.187	1,365,201	7.2	3.2
		4	28.1	1.076	648,582	3.1	1.4
		5	27.7	1.093	818,257	3.9	1.8
	LDDT with VMT mix of 1.4%	1	24.0	1.226	259,858	9.8	4.5
		2	24.3	1.210	2,924,040	109.3	49.6
		3	25.6	1.145	1,365,201	48.3	21.9
		4	28.1	1.038	648,582	20.8	9.4
		5	27.7	1.054	818,257	26.6	12.1
	HDDV with VMT mix of 7.4%	1	24.0	9.034	259,858	383.4	173.9
		2	24.3	8.915	2,924,040	4,256.9	1,930.9
		3	25.6	8.435	1,365,201	1,880.5	853.0
		4	28.1	7.649	648,582	810.1	367.5
		5	27.7	7.763	818,257	1,037.3	470.5
	MC with VMT mix of 0.5%	1	24.0	14.843	259,858	42.6	19.3
		2	24.3	14.651	2,924,040	472.7	214.4
		3	25.6	13.864	1,365,201	208.8	94.7
		4	28.1	12.511	648,582	89.5	40.6
		5	27.7	12.715	818,257	114.8	52.1

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
		1	15.0	14.486	59,240	1,143.8	518.8
LOCAL	LDGV	2	20.0	12.096	1,811,216	29,201.9	13,246.0
	with VMT	3	25.0	9.534	2,176,263	27,654.5	12,544.1
	mix of	4	25.0	9.534	1,080,974	13,736.3	6,230.8
	60.5%	5	30.0	7.808	172,453	1,794.8	814.1
		1	15.0	17.669	59,240	406.5	184.4
	LDGT1	2	20.0	14.835	1,811,216	10,435.9	4,733.7
	with VMT	3	25.0	11.938	2,176,263	10,090.5	4,577.0
	mix of	4	25.0	11.938	1,080,974	5,012.1	2,273.5
	17.6%	5	30.0	9.956	172,453	666.9	302.5
		1	15.0	21.780	59,240	244.9	111.1
	LDGT2	2	20.0	17.907	1,811,216	6,155.5	2,792.1
	with VMT	3	25.0	14.409	2,176,263	5,951.4	2,699.5
	mix of	4	25.0	14.409	1,080,974	2,956.1	1,340.9
	8.6%	5	30.0	12.033	172,453	393.8	178.6
		1	15.0	29.310	59,240	145.6	66.0
	HDGV	2	20.0	21.768	1,811,216	3,306.2	1,499.7
	with VMT	3	25.0	17.080	2,176,263	3,117.1	1,413.9
	mix of	4	25.0	17.080	1,080,974	1,548.3	702.3
	3.8%	5	30.0	14.160	172,453	204.8	92.9
		1	15.0	2.039	59,240	0.5	0.2
	LDDV	2	20.0	1.540	1,811,216	12.3	5.6
	with VMT	3	25.0	1.217	2,176,263	11.7	5.3
	mix of	4	25.0	1.217	1,080,974	5.8	2.6
	0.2%	5	30.0	1.007	172,453	0.8	0.3
		1	15.0	1.967	59,240	3.6	1.6
	LDDT	2	20.0	1.486	1,811,216	83.2	37.7
	with VMT	3	25.0	1.174	2,176,263	78.9	35.8
	mix of	4	25.0	1.174	1,080,974	39.2	17.8
	1.4%	5	30.0	0.971	172,453	5.2	2.3
		1	15.0	14.491	59,240	140.2	63.6
	HDDV	2	20.0	10.944	1,811,216	3,237.0	1,468.3
	with VMT	3	25.0	8.650	2,176,263	3,074.1	1,394.4
	mix of	4	25.0	8.650	1,080,974	1,526.9	692.6
	7.4%	5	30.0	7.155	172,453	201.5	91.4
		1	15.0	23.728	59,240	15.5	7.0
	MC	2	20.0	17.833	1,811,216	356.4	161.7
	with VMT	3	25.0	14.220	2,176,263	341.5	154.9
	mix of	4	25.0	14.220	1,080,974	169.6	76.9
	0.5%	5	30.0	11.606	172,453	22.1	10.0

5.6 Summary of CO Emissions from Onroad Mobile Sources

Table 5-5 summarizes the calculated CO emissions by vehicle class, area, and facility type. Total CO emissions from daily onroad mobile sources for the Maricopa County nonattainment area for the 1999 carbon monoxide season are estimated to be 490,261 kilograms per day or 1,080,822 pounds per day.

NOTE: Consistent with the 1990 base year inventory, only seasonal emissions were calculated for this portion of the inventory. In consultation with Mary Ann Warner-Selph, EPA Emissions Inventory Branch, it was determined that annual emission estimates were unnecessary for the 1990 base year inventory.

5.7 Quality Assurance Process

5.7.1 VMT Estimates

Normal quality assurance (QA) procedures, including extensive automated consistency checks, were used by ADOT in developing the 1999 HPMS data. A revised version of the 1999 data, incorporating improved traffic count data, was submitted to the Federal Highway Administration in April 2001. Additionally, as recommended in the Appendix B Level II Quality Review Checklist of the Quality Review Guidelines for 1990 Base Year Emission Inventories, July 1992, VMT per gallon of gasoline consumed was calculated as a check of the VMT estimates as described in Appendix 5-5.

5.7.2 Emission Factor Estimates

The QA process performed on the MOBILE5a analyses included accuracy, completeness, and reasonableness checks. For accuracy and completeness, a system was used that included a two-layer, independent reviewer set-up. All hard copy and computer-based data entries as well as all calculations procedures were checked independently for accuracy and completeness by two different reviewers. Any errors found were corrected and the changes were then rechecked by the reviewers.

The entire onroad mobile source portion of the 1999 periodic CO inventory was reviewed by MAG staff that did not directly participate in its development. All comments were addressed.

5.7.3 Quality Review of 1999 Periodic CO Emission Inventory

The draft onroad mobile source portion of the 1999 periodic carbon monoxide inventory was reviewed using published EPA quality review guidelines for base year emission inventories (EPA Document 450/4-91-022, September 1991). The procedural review (Levels I, II, and III) included checks for completeness, consistency, and the correct use of appropriate procedures.

Table 5–5. Daily Onroad Mobile Source CO Emissions (in kg/day) by Vehicle Class, Area Type and Facility Type – Winter

FACILITY		VEHICLE CLASS			
TYPE	**AREA TYPE**	**LDGV**	**LDGT1**	**LDGT2**	**HDGV**
INTERSTATE, FREEWAY, & EXPRESSWAY	1	3,538.1	1,420.2	841.8	576.7
	2	27,689.1	11,347.4	6,869.3	4,138.3
	3	19,757.6	8,119.8	4,928.4	2,894.0
	4	10,522.5	4,440.3	2,764.9	1,268.7
	5	3,729.4	1,586.3	995.0	428.8
	TOTAL	65,236.6	26,914.0	16,399.4	9,306.4
PRINCIPAL ARTERIAL & MINOR ARTERIAL	1	2,682.7	986.2	581.9	303.0
	2	48,767.2	17,991.2	10,618.5	5,521.2
	3	50,478.7	18,782.0	11,092.7	5,771.6
	4	21,884.9	8,241.3	4,872.1	2,566.1
	5	7,308.2	2,846.2	1,685.4	970.4
	TOTAL	131,121.7	48,847.0	28,850.6	15,132.4
COLLECTOR	1	1,565.3	568.9	335.5	176.4
	2	17,379.1	6,324.3	3,729.5	1,958.9
	3	7,669.9	2,804.8	1,654.4	864.8
	4	3,291.3	1,214.7	716.9	372.7
	5	4,218.0	1,554.6	917.4	477.2
	TOTAL	34,123.7	12,467.3	7,353.7	3,850.0
LOCAL	1	518.8	184.4	111.1	66.0
	2	13,246.0	4,733.7	2,792.1	1,499.7
	3	12,544.1	4,577.0	2,699.5	1,413.9
	4	6,230.8	2,273.5	1,340.9	702.3
	5	814.1	302.5	178.6	92.9
	TOTAL	33,353.9	12,071.2	7,122.3	3,774.9
GRAND TOTAL		**263,835.9**	**100,299.4**	**59,725.9**	**32,063.7**

TYPE	**AREA TYPE**	**LDDV**	**LDDT**	**HDDV**	**MC**	**TOTAL**
INTERSTATE, FREEWAY, & EXPRESSWAY	1	1.9	12.9	501.4	45.3	6,938.3
	2	13.0	87.9	3,421.8	420.2	53,986.9
	3	9.1	61.2	2,384.5	306.2	38,460.7
	4	3.8	25.5	991.8	196.0	20,213.4
	5	1.2	8.4	326.2	73.0	7,148.3
	TOTAL	29.0	195.8	7,625.7	1,040.6	126,747.6
PRINCIPAL ARTERIAL & MINOR ARTERIAL	1	1.1	7.7	298.9	33.1	4,894.6
	2	20.7	139.8	5,443.6	601.9	89,104.1
	3	21.6	145.7	5,675.6	620.7	92,588.5
	4	9.5	64.3	2,504.5	267.1	40,409.9
	5	3.5	23.5	913.5	89.6	13,840.4
	TOTAL	56.4	381.0	14,836.1	1,612.3	240,837.5
COLLECTOR	1	0.7	4.5	173.9	19.3	2,844.5
	2	7.3	49.6	1,930.9	214.4	31,594.2
	3	3.2	21.9	853.0	94.7	13,966.8
	4	1.4	9.4	367.5	40.6	6,014.6
	5	1.8	12.1	470.5	52.1	7,703.6
	TOTAL	14.4	97.5	3,795.8	421.1	62,123.6
LOCAL	1	0.2	1.6	63.6	7.0	952.9
	2	5.6	37.7	1,468.3	161.7	23,944.8
	3	5.3	35.8	1,394.4	154.9	22,825.0
	4	2.6	17.8	692.6	76.9	11,337.4
	5	0.3	2.3	91.4	10.0	1,492.3
	TOTAL	14.1	95.3	3,710.3	410.5	60,552.4
GRAND TOTAL		**114.0**	**769.5**	**29,968.0**	**3,484.6**	**490,261.1**

Additionally, the draft onroad mobile source portion of the 1999 periodic carbon monoxide inventory was compared with the onroad mobile source portions of the 1990, 1993, and 1996 base year and periodic inventories. The results are in the following table.

Year of Analysis	Onroad Emissions (kg/season day)	Onroad Emissions (pounds/season day)	Vehicle Miles Traveled (VMT/season day)
1990	732,745	1,615,399	45,877,773
1993	553,943	1,221,215	48,153,240
1996	508,259	1,120,500	53,091,273
1999	490,261	1,080,822	57,853,980

While the VMT increases over time, the modeled onroad CO emissions continue to decrease, principally because of a vehicle fleet with cleaner engine and emission control technologies, augmented by local controls such as the I/M program and cleaner gasoline. It is important to note that the base case emissions from the Serious Area CO Plan may not match those in the periodic inventories because of a different year modeled and different modeling domain size.

5.8 References for Section 5

Emission Inventory Requirements for Carbon Monoxide State Implementation Plans, EPA-450/4-91-011, March 1991.

MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, MAG, June 1999.

Maricopa Association of Governments Highway Performance Monitoring System Update, Lee Engineering, Inc., for MAG, January 1995.

1986 Phoenix Urbanized Area Travel Speed Study, Parsons Brinkerhoff Quade & Douglas, Inc., for MAG, October 1986.

1993 Study of Travel Speed and Delay in the MAG Region, Lee Engineering, Inc., for MAG, January 1995.

Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA-450/4-81-026d (Revised), 1992.

Quality Review Guidelines for 1990 Base Year Emission Inventories, EPA-454/R-92-007, July 1992.

User's Guide to MOBILE5 (Mobile Source Emission Factor Model), EPA-AA-AQAB-94-01, May 1994.

SECTION 6. QUALITY ASSURANCE

6.1 Introduction

This section describes the Quality Assurance (QA) procedures followed by the Maricopa County Environmental Services Department (MCESD) in the production of this 1999 periodic carbon monoxide emissions inventory for the Maricopa County nonattainment area. This section does not include the QA procedures taken when preparing the onroad mobile section of this inventory which are described in Section 5.7. When preparing stationary point, stationary area, and the aircraft and locomotive section of nonroad mobile sources these procedures were followed:

1. Reviewing the descriptive information included in each section to assure completeness, clarity and correctness;
2. Inspecting formulas, calculations and conversions to assure autonomy from errors and inconsistencies;
3. Evaluating data quality to assure the value of the inventory, both as a representative data set of the state of the air environment in the Maricopa County nonattainment area and as the reference point for future inventories; and
4. Assessing, where possible, the significance of the calculated quantities to assure reasonable accuracy and admissible precision.

The QA section of the Maricopa County emissions inventory follows the QA/QC plan in the Inventory Preparation Plan for the 1999 Periodic CO Emission Inventory (MCESD, 2001). This should show, without ambiguity, that Maricopa County's QA plan was implemented.

6.2 Purpose of an Emissions Inventory

Several objectives motivated the development of the emissions inventory:

1. To comply with the inventory requirements of the Federal Clean Air Act Amendments of 1990 and specifications of the U.S. Environmental Protection Agency;
2. To provide a baseline against which to evaluate trends and successes in CO emission reduction efforts;
3. To support development of air quality models and planning activities; and,
4. To underscore particular concerns and to direct attention to areas where significant air quality improvement is achievable.

To assure production of an emissions inventory that is complete, accurate, and in compliance with requirements set forth in the EPA document Guidance for the Preparation of Quality Assurance Plans for Ozone / Carbon Monoxide SIP Emission Inventories, four operational steps were followed: 1) planning; (2) collecting data, distinguishing point sources from area sources and establishing data collection procedures appropriate for each type of source considered; (3) analyzing data and developing emission estimates for each type of source; and (4) summarizing and reporting data.

6.3 Quality Assurance Staff

The Quality Assurance program staff is comprised of:

Renee Kongshaug, MCESD	Internal QA Coordinator
Bob Downing, MCESD	Point sources
Ruey-in Chiou, MAG	Highway vehicle emissions
Randy Sedlacek, ADEQ	Oversight and external QA

6.4 Implementation

Quality assurance checks occurred on receipt of data (missing and/or questionable data), on completion of calculations (computational methods, accuracy, reasonableness), on formatting of data (transcription errors, reasonableness either on a facility or categorical basis), and on inventory assembly (completeness, reasonableness). The QA point and area source coordinator reviewed the Inventory Preparation Plan (IPP) (MCESD, 2001), checked calculations, identified errors, performed completeness, reasonableness and accuracy checks.

Data collection procedures followed EPA guidance to assure inclusion of all source categories in the inventory. A listing of point sources was assembled from the existing point source inventory and the county's inventory database, EMS (described in Section 2). Any questionable data were verified by telephone, fax or e-mail. Examples of data collection and data verification procedures are included in Appendix 2–1.

Data quality was evaluated using several approaches. Data were cross-checked where multiple sources were available, and activity-level based data were given preference. All calculations were reviewed for accuracy and method consistency, and those calculations done in spreadsheets were recalculated with a calculator or by hand as an error checking procedure. Examples of these recalculations are included in Appendix 2–1.

MCESD made necessary corrections to the inventory as errors were revealed through its own QA procedures and as recommended by other agencies. As a final check before the inventory was considered complete, MCESD staff completed the electronic inventory review checklists (see Appendix 6–1). These checklists cover Level I and Level II checks (EPA, August 1992). During this final review, staff discovered only minor areas that needed attention. Data handling and reporting essentially is a reflection of EPA guidance documents and data reporting requirements. External comments made while reviewing the draft document are included in Appendix 6-2.

6.5 Review and Evaluation of Inventory Elements

6.5.1 General Statement

The general plan of the quality assurance program is described in the IPP (MCESD, 2001). Formal training sessions for inventory personnel were provided by EPA training workshops, as available. Informal training sessions for MCESD inventory staff were held as further EPA guidance became available. Topics covered in these sessions included:

1. Contents of existing and new EPA emissions inventory-related guidance or policy.
2. New or updated data sources or procedures for determining emissions estimates.
3. National Emission Inventory/ NIF training.
4. MCESD policy and standard operating procedures.

New personnel received briefings from their respective supervisors. However, most of their training regarding the details of their duties was received while on the job. Training materials (e.g., books and manuals) were available to familiarize new personnel with inventory work.

6.5.2 Point Sources

Two environmental planners checked inventory accuracy, reasonableness and assured that all point sources had been identified and that the methodology applied to calculate emissions was appropriate and that the calculations were correct. Other reasonableness checks were conducted by recalculating emissions by using methods other than those used to make the initial emissions calculations and then by comparing results. A quality assurance check of EMS was made on all SCC codes for determining the appropriate categories for facility's emission units. Quality analysis (QA) was conducted by checking all emissions reports submitted to MCESD for the year 1999 for missing and questionable data and by checking the accuracy and reasonableness of all emissions calculations made for such reports. Notes concerning follow-up calls and corrections to calculations were documented on each 1999 annual emissions report.

Data entry for the NEI will be verified against the original hardcopy files for completeness and reasonableness. Since some data sources are more reliable than others, it is important that the reliability of the data be taken into account. For this reason, MCESD assessed all data against the capabilities and biases (if any, and if known) of the organization supplying the data, the techniques used to collect the data (if known), and the purpose for which the data were compiled. This assessment allowed MCESD to understand the limitation of the data and to choose the best data for developing emissions estimates.

Inconsistencies were located in the data presentation (i.e. significant figures) and were corrected. General corrections to format were made including references to specific appendices. Text was added to clarify how peak CO season daily emissions were calculated. There had been some facility name discrepancies that were corrected. Text was added to clarify that the power plant peak CO season daily emission estimates came from data provided by each source for a worst case day in 1999. Text was also added to clarify that all point sources were re-inventoried and to outline the criteria for a facility to be included as a point source.

6.5.3 Area Sources

In the creation of the area source emissions inventory, two environmental planners checked data and calculations for accuracy, completeness and reasonableness and then reviewed the methodology, and rechecked data for completeness, reasonableness, and a sample of the calculations. All miscalculations were corrected and then rechecked. All issues were discussed. A number of format changes were made along with adding more text, a new category and some changes in methodology.

The external reviewer checked accuracy in methodology based on the Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I (EPA, May, 1991) document. It was verified that all source categories listed in the Emission Inventory Requirements for Carbon Monoxide State Implementation Plans (EPA, March 1991) document were included. Reasonableness checks were performed by recalculating emissions using alternate methodologies and by comparing results and/or analyzing totals and inputs to determine reasonableness.

Significant figures inconsistencies were located in the data presentation and were corrected. Example calculations were added to each section for clarity. Conversations with the natural gas suppliers led to corrections to the document and calculations. General corrections to format were made including references to specific appendices.

Stationary Area Sources - Fuel Combustion

Input data in this source category are of high quality and verifiable by independent calculation. Within Maricopa County, natural gas is the principal fuel burned. Quantities of natural gas distributed to sub-categories (e.g. Electric Utilities, Industrial, etc.) were obtained from three distribution sources and were subtracted from point source usage (data obtained from EMS, Maricopa County's database) to estimate area source usage. These calculations were rechecked and a few errors from inconsistent emission factors or coding discrepancies were corrected.

Stationary Area Sources - Other Combustion

This category combined several miscellaneous sources, many with roughly estimated emission factors. Qualitative dimensional assumptions and gross estimates of the quantities of materials burned were made. However, these reported quantities are so large, and their calculated contributions to the CO emission inventory of area sources are so significant, that they may overwhelm the more substantiated emission values of other sources.

This is especially true in the case of wood burning in fireplaces and woodstoves. This sub-category accounts for 87% of the reported 1999 CO emissions contributed by "Other Combustion" sources (2,830.2 tons/year of a total 3,241.2 tons/year), yet the reported emission level is based on questionable assumptions of fireplace population and of the extent of the wood burning season.

Similar reservations exist for the sub-category "Structure and Motor Vehicle Fires"; however, the total reported emissions of this group are a much less significant contribution to the inventory.

6.5.4 Nonroad Mobile Sources

The quality assurance process for 1999 aircraft and locomotive CO emissions engaged the efforts of two environmental planners validating input data and performing calculations and reasonableness checks on each other's work. This was followed by an external reviewer's check of the section. The QA coordinator checked for accuracy, reasonableness, completeness of emission sources and logical methodology based on chapters five and six of the EPA Emission Inventory Preparation Document (EPA, 1992). Several formatting inconsistencies were found and corrected. Additional reference material was requisite to document sources of information, and therefore included. An error in aircraft operations was discovered, and the correction created a series of amendments to the document and calculations. All issues were addressed and corrected.

General corrections to format were made including references to specific appendices. References were added to indicate the source of aircraft activity information for each airport.

6.5.5 Onroad Mobile Sources

See Section 5.7 of this document for the quality assurance narrative regarding this category.

6.6 Summary Statement

The accuracy of this inventory is a measure of the quality of our knowledge of the day-to-day, seasonal and annual statistics of emissions sources in the Maricopa County nonattainment area. Although effort was made to ensure that the data expressed in this inventory accurately represents the emissions in the nonattainment area in 1999, all components of the inventory, taken together, are subject to continued improvement.

The degree to which we are able to improve the quantity and accuracy of source data will determine the quality and reliability of future inventories. Efforts will be focused on obtaining valid and reliable information as well as improving emission calculation methods for future inventories.

6.7 References for Section 6

Maricopa County Environmental Services Department. Inventory Preparation Plan: Carbon Monoxide. April 2001.

U. S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. I. EPA-450/4-91-016. May 1991.

U. S. Environmental Protection Agency. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. EPA-450/4-91-011. March 1991.

U. S. Environmental Protection Agency. Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA-450/4-81-026d (Revised), Chapter 5. Office of Mobile Sources. Ann Arbor, MI. 1992.

U.S. Environmental Protection Agency. Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA-450/4-81-026d (Revised), Chapter 6. Office of Mobile Sources, Ann Arbor, MI. 1992.

U. S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. III: Emission Inventory Requirements for Photochemical Air Quality Simulation Models, EPA-450/4-91-014. May, 1991.

U. S. Environmental Protection Agency. Guidance for the Preparation of Quality Assurance Plans for Ozone/Carbon Monoxide SIP Emission Inventories. EPA-450/4-88-023.

U. S. Environmental Protection Agency. Quality Review Guidelines for 1990 Base Year Emissions Inventories, EPA-450/4-91-022. August 1992.

U.S. Environmental Protection Agency. EIIP Volume VI: Chapter 3 General QA/QC Methods, June 1997.

APPENDIX A

EXHIBIT 2

Technical Support Document for Carbon Monoxide Modeling in Support of the Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. March 2003.

DRAFT

TECHNICAL SUPPORT DOCUMENT

FOR

CARBON MONOXIDE MODELING IN SUPPORT OF THE CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

April 2003

Maricopa Association of Governments
302 North 1st Avenue, Suite 300
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ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AIRS	Aerometric Information Retrieval System
AZMET	Arizona Meteorological Network
CAAA	Clean Air Act Amendments of 1990
DWM	UAM Diagnostic Wind Model
EPA	U. S. Environmental Protection Agency
EPS2.0	UAM Emissions Preprocessor System version 2.0
GIS	Geographic Information Systems
I/M	Inspection and Maintenance
MAG	Maricopa Association of Governments
MCESD	Maricopa County Environmental Services Department
MCFCD	Maricopa County Flood Control Department
MIXEMUP	Mixing-height Estimation Methodology for UAM Purposes
NAAQS	National Ambient Air Quality Standards
NWS	National Weather Service
PRISMS	Phoenix Realtime Instrumentation for Surface Meteorological Studies
RVP	Reid Vapor Pressure
RWC	Residential wood combustion
SIP	State Implementation Plan
UAM	Urban Airshed Model

SECTION 1. INTRODUCTION

A CO Maintenance Plan is one of several requirements necessary for EPA to redesignate the Maricopa County Nonattainment Area to attainment. As the designated regional air quality planning agency, MAG conducts the modeling for emissions and air quality concentrations and prepares the air quality plans.

The primary requirement of the CO maintenance plan is to demonstrate that the 8-hour CO standard will be maintained for at least ten years after the area is officially redesignated to attainment by EPA. In determining the amount of lead time to allow, EPA indicated that 18 months, as granted in section 107(d)(3)(D) of the Clean Air Act Amendments, should be assumed for EPA to approve a redesignation request [1]. Due to uncertainties regarding when the area will be redesignated to attainment, the year 2015 has been modeled to assure that the 8-hour CO NAAQS is maintained at least ten years after an official notice of redesignation to attainment by the EPA.

In addition to the maintenance demonstration, a maintenance plan must contain a contingency plan which contains the contingency provisions necessary to ensure prompt correction of any violation of the CO standard that may occur during the maintenance period. The contingency plan should contain clearly identified contingency measures, a schedule and process for consideration of additional contingency measures, if necessary, and a specific time limit for action by the State. In addition, specific indicators should be identified which will be used to determine when additional contingency measures are necessary.

On January 29, 2002, EPA announced the official release of the MOBILE6 [26] model and triggered the two-year grace period for local agencies to utilize MOBILE6 in SIP revisions and transportation conformity analyses. The present Maintenance Plan was prepared using the EPA MOBILE6 model to develop on-road mobile source emissions.

I-1. Background

Following the requirements of the 1990 Clean Air Act Amendments (CAAA), EPA initially identified the MAG region as a Moderate CO nonattainment area. The CO nonattainment area encompasses 1,962 square miles, or approximately 22 percent of the area of Maricopa County. The MAG region was officially reclassified as a Serious nonattainment area for carbon monoxide, by operation of law, effective August 28, 1996, because attainment of the CO standard was not achieved by December 31, 1995. The area is required to meet the NAAQS as expeditiously as practicable, but no later than the deadlines set forth in the CAAA. The attainment date specified by the CAAA for Serious CO nonattainment areas is December 31, 2000.

The MAG1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area [10], demonstrating attainment of the CO NAAQS by December 31, 2000, was submitted to EPA in July 1999. Subsequent to the submission of the MAG 1999 Serious Area Carbon Monoxide Plan, the Arizona Legislature passed House Bill 2104 during the 2000 regular session, which repealed the Random Onroad Testing

Requirements ("remote sensing program") from the Vehicle Emissions Inspection Program. House Bill 2104 also required the Director of the Arizona Department of Environmental Quality (ADEQ) to evaluate the feasibility and effectiveness of methods to improve the monitoring of the performance of in-use emission control systems using alternative technologies.

EPA then indicated that the 1999 CO Plan [10], including the attainment demonstration for December 2000, would need to be revised to reflect the repeal of the remote sensing program. In response, the air quality modeling submitted to EPA in July 1999 was revised accordingly and resubmitted to EPA as the Revised MAG 1999 Serious Area Carbon Monoxide Plan [11] in March 2001.

The Revised CO Plan reflects the discontinuation of the remote sensing program, but still demonstrates attainment of the CO standard by December 31, 2000. Air quality monitoring data in Maricopa County confirm that the attainment date of December 31, 2000 was met, since no violation of the CO standard has occurred at any monitor since 1996. As a result of the "clean" data at the monitors, the State of Arizona requested a CO attainment determination from EPA on July 23, 1999. Redesignation to attainment has several requirements, in addition to an approved attainment plan, including an approved maintenance plan.

I-2. Overview of Study

The main objective of the modeling analysis is to estimate the effects of growth and emission-reduction strategies on the future carbon monoxide air quality in the nonattainment area. The results of the modeling analysis are intended to provide a quantitative assessment of the potential for compliance with the federal CO standard and, thus, the basis for the development of the Maintenance Plan.

A protocol document (see Appendix.I, Exhibit One) was developed to detail the technical approach used to demonstrate maintenance of the ambient air quality standards for CO in the Maricopa County area. The protocol contains the information recommended in the EPA Guideline [21]. The modeling work documented in this Technical Support Document (this document) follows the modeling details outlined in the Protocol. In accordance with 40 CFR Part 93 Section 93.118(b), MAG will use the new interim mobile source carbon monoxide emissions budget for the conformity horizon years of 2006 through 2014 and the new 2015 mobile source carbon monoxide emissions budget for conformity horizon years after 2014.

The EPA recommended [21] Urban Airshed Model version IV (UAM-IV) was employed to simulate the CO concentrations in the study area. The mixing depths were calculated using the Mixing-Height Estimation Methodology for UAM Purpose (MIXEMUP) [6] procedure. The wind fields were generated using the Diagnostic Wind Model (DWM) [4] which is included in the UAM program package. The UAM Emissions Preprocessor System (EPS2.0) [2] was used to process the emissions inventories where the onroad mobile emissions were generated by the EPA MOBILE6 model [26] and M6Link. M6Link is a MAG software program applied at the transportation link level to generate gridded mobile source emissions for input to UAM. The EPA recommended CAL3QHC [25] was used for analyzing CO impacts at roadway intersections.

Because UAM accounts for spatial and temporal variations, it is well suited for evaluating the effects of emission control strategies on urban air quality. An evaluation of the model performance for the UAM CO modeling effort was accomplished by replicating the 1994 CO episode within the EPA prescribed statistical criteria. The December 16-17, 1994 episode was selected according to the procedures described in the Protocol document which is provided in Appendix I, Exhibit One.

Once the model results had been evaluated and the model had performed within the prescribed levels, the emissions inventory was modified to represent CO emissions in the maintenance year of 2015, with additional control measures. The model was then exercised using the 2015 emission inventory. The resulting carbon monoxide concentrations were used to infer the impact of the emission changes for modeling episode-specific meteorological conditions. This information was used to evaluate maintenance of the carbon monoxide standard.

The UAM modeling analysis consisted of the following tasks:

(1) Preparation of a modeling protocol (including selection of the modeling domain and simulation periods)

(2) Preparation of day-specific UAM modeling emission inventory

(3) Microscale analysis

(4) Completion of the maintenance demonstration

(5) Completion of the Technical Support Document (this document)

Unless otherwise noted, all the hour-long periods of time mentioned in this document are referred to by the ending hour of the one hour period (e.g. “@ 1200 MST” means hour ending at 1200 MST).

I-3. Data Access Procedure

A summary of the computer files used for the air quality modeling in support of the Carbon Monoxide Maintenance Plan is contained in Appendix I, Exhibit Two. The file and model descriptions are grouped by computer program or model and are presented in logical order from emission rate estimates through the final output from UAM. As a result, the file summary also provides a sequential outline of the overall air quality modeling chain.

A comprehensive list of the names of files which are provided on tape follows the job file lists and description. The comprehensive file list is not generally presented in the order in which the named files were employed. Rather, the comprehensive list is ordered alphabetically by subdirectory name.

For clarity, the job file lists indicate the names of the job control files which were used to run each program. Each job control file is the executable file which was used to run the particular air quality model or program for a particular day or scenario. Note that some air quality models were not run by job file (i.e. MOBILE6) and, therefore, no job files are listed. Also, some air quality models have very simple job files (i.e. M6Link) whose purpose is calling a larger control file. Since these job files are very simple, only a sample job file was provided. These sample job files may be changed easily to call a different control file. All input and output files are organized on the data tape by program or model in separate subdirectories.

Files have been placed in the tape directory structure by model or program. It is important to note that the tape directory structure is not identical to the directory structure on the MAG computers. As a result, job files, while calling the correctly named input and output files, may not search for those files in the correct directories as they appear on the data tape. Editing or moving files may be necessary to reproduce MAG runs using job files found on the data tape.

I-4. Structure of the Document

Section II of this Technical Support Document describes the modeling domain and episode selections. Section III details the input preparation for running UAM for the historical carbon monoxide episode. Section IV illustrates the methods and procedures used for quality assurance and diagnostic analyses. Section V describes the microscale modeling. Section VI contains the base case simulation results and performance evaluations. Section VII presents the modeling details for maintenance demonstration.

Each appendix was numbered to correspond to a section with the same number. Sections that do not need supplemental materials have no corresponding appendices. Therefore, Appendices II and VI do not exist, because no supplemental materials were needed for Sections II and VI.

SECTION II. MODELING DOMAIN AND EPISODE ISSUES

II-1. Aerometric Data Bases

Meteorological and air quality data used for the UAM modeling applications were collected from all available valid monitoring sites in or around the nonattainment area. The Arizona Department of Environmental Quality (ADEQ) and the Maricopa County Environmental Services Department (MCESD) maintain networks collecting both air quality and meteorological data. Additional surface meteorological data were collected from other monitoring networks including those maintained by Maricopa County Flood Control Department (MCFCD), National Weather Services (NWS), and Phoenix Realtime Instrumentation for Surface Meteorological Studies (PRISMS). It should be noted that there is no upper air station in the modeling domain. The available upper air station closest to the domain is in Tucson which is about 110 miles south of Phoenix. Data availability for the December 16-17, 1994 episode is summarized in Table II-1.

Air quality data generally served two purposes. First, data were used to specify initial and boundary concentrations. Second, ambient measurements were used to assess the ability of the model to replicate a historical episode, that is, to evaluate model perfomance for the base case. These topics are addressed in the relevant sections of the Technical Support Document.

II-2. Base Meteorological Episode Selection

The modeling episode day in the MAG Serious Area CO Plan [10] was used in the CO maintenance plan. The episode day for the serious area CO plan was selected based on a review of the 1994 to 1996 monitoring data. There have been no exceedances of the CO NAAQS since 1996. Therefore, it is appropriate to continue to use the December 17, 1994 episode day for the CO maintenance plan with the prior day for initialization purposes. An analysis of the carbon monoxide climatology of the area using data from 1994 to 1996 was documented in a memorandum dated September 16, 1996 and is contained in Appendix B of the MAG Serious Area CO Plan [10].

Peak eight-hour CO concentrations above 9 ppm were recorded at three monitors in the early morning of December 17, 1994. Since the episode day is on Saturday, the UAM simulations were initiated at 1200 MST on Friday. Monitoring data were reviewed for Friday, December 16, 1994 and noon was selected for initialization because of the uniform observed CO field, which helps to reduce any potentially large initial error. To further minimize errors introduced by the initial conditions, the simulated concentrations for the first hour were discarded before conducting any analyses.

II-3. Modeling Domain

Selection of the modeling domain was based on the distribution of major emissions sources, the locations of the meteorological and air quality monitoring sites, and the typical wind directions associated with carbon monoxide episodes. Locations of the major power plants are listed in Table II-2. The UAM modeling domain for this analysis is approximately centered on the urbanized portion of Maricopa County. A map of the modeling domain, with contours representing terrain height in meters, is presented in Figure II-1. The geographical location of the modeling domain is illustrated in Figure II-2, the shaded area represents the EPA-designated carbon monoxide nonattainment area. The modeling domain consists of 33 grid cells in the west-east direction and 24 grid cells in the south-north direction.

II-4. Horizontal Grid Resolution

The horizontal grid resolution to be applied to the modeling domain is one mile by one mile, or 1.609 kilometers by 1.609 kilometers. The one-mile grid allows resolution of the major emission sources including the link-based mobile-source inventory and is consistent with the recommendation in the EPA CO modeling guidelines that grid cells should be no larger than two kilometers.

II-5. Number of Vertical Layers

Two vertical layers (one below and one above the mixing height) were used for the simulations, with one layer above the morning mixing height which is called “diffusion break” in UAM. The top of the modeling domain (which is called “region top” in UAM) was specified above the mixing height by at least the depth of one upper layer cell. This was done by setting the region top value equal to the maximum mixing depth plus the minimum depth of the upper layer cells. Minimum vertical cell size was 20 m below the diffusion break and 20 m above it, following the EPA Guidelines [4].

Table II-1. Data availability for the Maricopa County region for the December 16-17, 1994 episode.

Network	Within CO UAM	Site Name	Site I.D.	Site Index *	UTM Zone 12 Easting (km)	UTM Zone 12 Northing (km)	Upper	Wind	Temp	Press	CO
ADEQ	✓	Bank One Tower	BNKO		400.30	3701.55			✓		
	✓	Phoenix Post	PHPO	2	400.66	3706.40					✓
	✓	Phoenix	PHSS	1	399.19	3707.18					✓
	✓	Phoenix Grand	PHGA	11	396.37	3705.08					✓
		Palo Verde	PALV		327.16	3695.25		✓	✓	✓	
MCESD	✓	W. Indian School	WISR	10	394.80	3706.20		✓			✓
	✓	West Phoenix	WPHX	6	393.20	3705.90		✓			✓
	✓	Central Phoenix	CPHX	3	403.20	3702.50		✓			✓
	✓	South Scottsdale	SSCT	8	414.00	3704.60		✓			✓
	✓	Mesa	MESA	9	419.60	3697.50		✓			✓
		Pinnacle Peak	PINN		420.70	3729.70		✓			
	✓	North Phoenix	NPHX	7	400.90	3714.40					✓
	✓	Glendale	GLEN	5	389.30	3714.60		✓			✓
	✓	South Phoenix	SPHX	4	400.10	3696.70		✓			✓
		Falcon Field	FALC		432.20	3701.20		✓			
	✓	Freeway	FREE	14	397.09	3702.88					
	✓	Gilbert	GILB	13	428.19	3691.26					✓
	✓	Maryvale	MARY	12	389.30	3704.23					✓
	✓	Ocotillo	OCOT	16	395.31	3710.96					✓
	✓	West Chandler	WCHA	15	416.87	3685.35					
NWS	✓	Sky Harbor	SKYH		405.20	3699.20		✓	✓	✓	
		Tucson/Int'l Arpt	TUCS		507.55	3553.54	✓	✓	✓	✓	
		Winslow/Mun Arpt	WINS		525.55	3875.11	✓				

Table II-1. Data availability for the Maricopa County region for the December 16-17, 1994 episode (continued).

Network	Within CO UAM	Site Name	Site I.D.	Site Index *	UTM Zone 12 Easting (km)	UTM Zone 12 Northing (km)	Upper	Wind	Temp	Press	CO
NWS		Flagstaff/Pulliam	FLAG		438.95	3887.47		✓	✓	✓	
		Prescott/Municipa	PRES		368.94	3834.97		✓	✓	✓	
	✓	Alameda	ALAM		414.51	3695.41		✓	✓	✓	
	✓	Arcadia	ARCA		406.85	3708.08		✓	✓	✓	
	✓	Collier	COLL		380.16	3703.14		✓	✓	✓	
	✓	Corbell	CORB		422.95	3690.97		✓	✓	✓	
		Falcon	FACN		431.95	3703.34		✓	✓	✓	
		Fountain	FOUN		434.20	3717.83		✓	✓	✓	
PRISMS	✓	Kay	KAY		392.83	3697.47		✓	✓	✓	
	✓	Pera	PERA		412.77	3702.94		✓	✓	✓	
	✓	Pringle	PRIN		397.20	3714.89		✓	✓	✓	
		Rittenhouse	RITT		440.64	3680.16		✓	✓	✓	
	✓	Sheeley	SHE		386.98	3705.64		✓	✓	✓	
	✓	Stapley	STAP		425.24	3699.42		✓	✓	✓	
		Stewart Mountain	STEW		450.49	3713.12		✓	✓	✓	
		Sun Lakes	SUNL		418.53	3676.31		✓	✓	✓	
		Superstition	SUPR		450.10	3697.63		✓	✓	✓	
		Spurlock	SPUR		457.64	3690.91		✓	✓	✓	

* Site indices refer to Figure III-2.

Table II-2. Major power plants in the Maricopa County.

Power Plant	Location	City	UTM (Zone 12, km)	
			Easting	Northing
APS West Phoenix Power Plant	Hadley St.	Phoenix	392414	3701190
Duke Energy Arlington Valley [1] LLC.	Elliot Rd.	Arlington	324282	3690470
Harquahala Generating Co. LLC. [1]	Harquahala Valley Rd.	N/A[2]	303688	3705787
Mesquite Generating Station [1]	Elliot Rd.	Arlington	326602	3691016
Ocotillo Power Plant	University Dr.	Tempe	415224	3698573
Palo Verde Nuclear Generating Station [1]	Wintersburg Rd.	Tonopah	325615	3696527
Panda Gila River LP. [1]	Watermelon Rd.	Gila Bend	341737	3649850
Pinnacle West Energy Corp. [1]	363rd Ave.	Arlington	328940	3690200
Santan Generatin Plant	Val Vista Dr.	Gilbert	430407	3688183
SRP Agua Fria	Northern Ave.	Glendale	387108	3713387
SRP Kyrene Steam Plant	Kyrene Rd.	Tempe	412877	3691004
Gila Bend Power Generation [1] Station	Citrus Valley Rd.	Gila Bend	329845	329845

[1] The power plants were expected to be in operation after 1994.

[2] Harquahala Generating Co. LLC is in an unincorporated section of Maricopa Cty., near the
intersection of Courthouse and Harquahala Valley Rds.

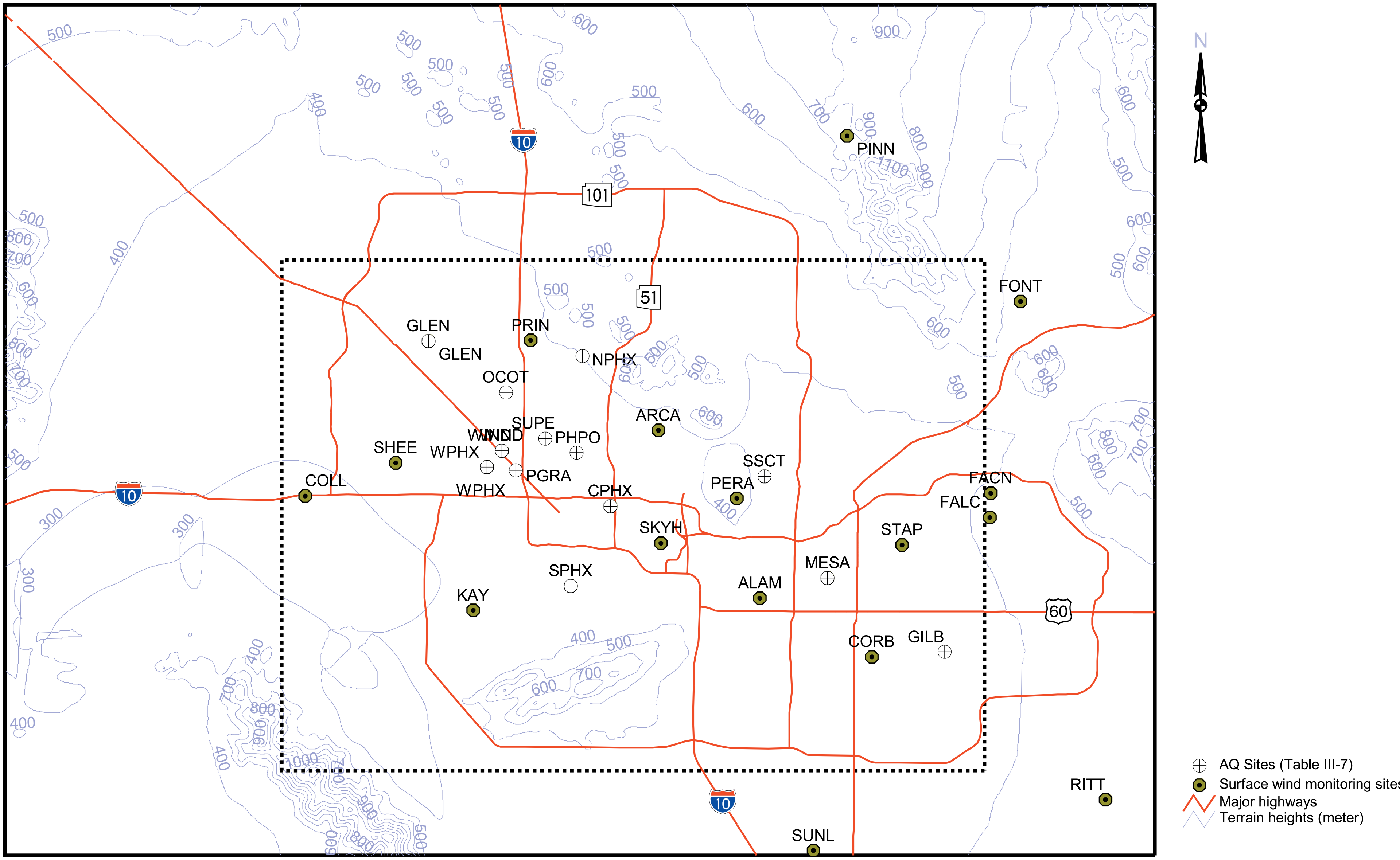


Figure II-1. The larger domain was used in the DWM wind fields. The isopleths represent terrain elevations. The inner rectangle denotes the location of the CO UAM domain. Note: Flagstaff, Palo Verde, Prescott, Spurlock, Stewart Mt., Tucson and Winslow sites are not shown because the sites are out of DWM wind domain.

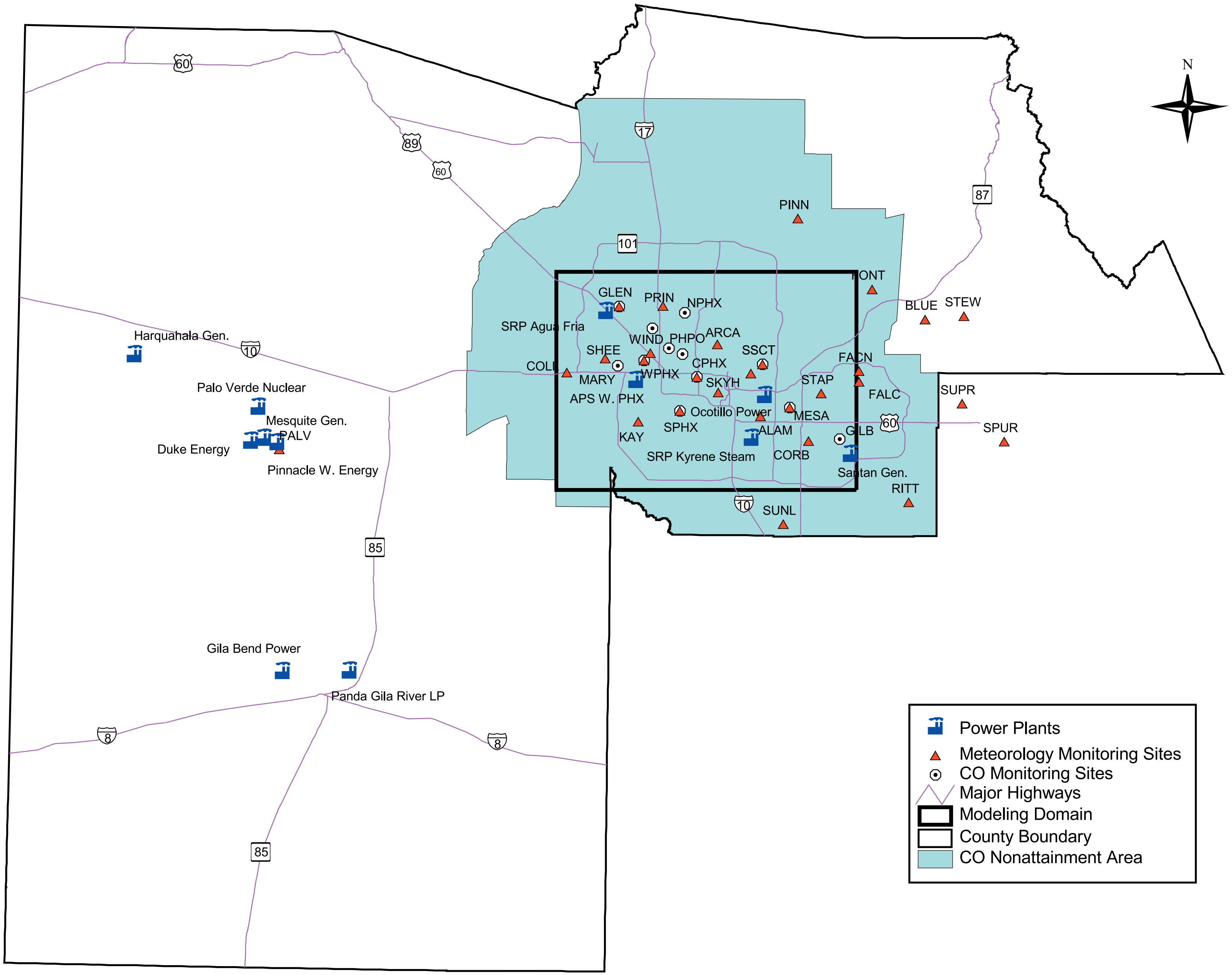


Figure II-2. The geographical location of the modeling domain where the shaded area represents the EPA-designated carbon monoxide nonattainment area.

SECTION III. BASE CASE UAM INPUT PREPARATION

MAG, in cooperation with the Arizona Department of Environmental Quality (ADEQ), the Arizona Department of Transportation (ADOT), and the Maricopa County Environmental Services Department (MCESD), has elected to apply the EPA-recommended Urban Airshed Model (UAM), a three-dimensional grid model, to the Maricopa County urban planning area for the evaluation of carbon monoxide maintenance strategies. UAM-IV was applied in this analysis, with CO being the only species modeled. Although CO is involved as a reactive agent in the summertime production of tropospheric ozone, it is treated as an unreactive species for wintertime CO modeling.

The UAM inputs include: day-specific emission inventories; meteorological inputs for the modeled episode; air quality inputs for the modeled episode; and other inputs such as gridded land use information for the modeling domain and chemistry parameters. The inputs were prepared in accordance with the general guidelines established by the U.S. EPA for the regulatory application of the UAM [21] as outlined in the UAM modeling protocol (Appendix I).

It should be stressed that several UAM input parameters play insignificant (if any) roles in inert two-layer UAM applications. In particular, water vapor, radiation factor, atmospheric pressure, and temperature gradient below the DIFFBREAK are ignored in inert UAM simulations. Only the combination of exposure class and temperature gradient above the DIFFBREAK are used to parameterize mixing across the DIFFBREAK (which is important during the afternoon, but minimal under stable nighttime regimes). Therefore, the key meteorological inputs that control UAM CO predictive performance are the three-dimensional wind fields, the DIFFBREAK, and to a much lesser extent, the exposure class.

III-1. Emission Inventory

This section summarizes the development of the base year 1994 carbon monoxide (CO) emission inventories for use in the Urban Airshed Model (UAM). The UAM Emissions Preprocessor System (EPS2.0) [2] was used to process the emissions inventories including point, area, aviation, and nonroad mobile sources. The onroad mobile emissions, which are the major source of CO emissions in the Maricopa County Nonattainment Area, were generated by the EPA MOBILE6 model and M6Link. M6Link is a MAG software program applied at the transportation link level to generate gridded mobile source emissions compatible with UAM. CO emissions from sources other than onroad mobile emissions, including point, area, and nonroad mobile sources, are considered “background” emissions. All onroad mobile and background emissions were merged by EPS2.0 to be ready for input to UAM. The development of the 2015 committed maintenance measures package inventory is documented in Section VII-3.

UAM emission input files have been developed for December 16-17, 1994. The 1994 inventory reflects control measures in place at that time. It is important to note that the

December 16-17, 1994 episode days comprise a Friday-Saturday period. A higher degree of uncertainty associated with weekend emission inventories has precluded some applications of UAM. However, it is important to point out that the CO exceedances on the episode day occurred very early on Saturday morning (i.e., 3 and 4 a.m.). As a result, it is assumed that the Friday emissions are critical to the build up of CO concentrations that yield Saturday morning exceedances.

III-1-1 ONROAD MOBILE SOURCE EMISSIONS

The first step in developing onroad mobile emissions is to estimate emission factors. A very large array of mobile emission factors is required by the M6Link model to produce a complete motor vehicle emissions inventory. These factors, in units of grams per mile, are multiplied by vehicle miles traveled (VMT) in each grid cell of the modeling domain to produce the onroad mobile source emissions estimates. These factors are unique by vehicle type, vehicle age, hour of the day, and facility type the vehicle is driving on. Emission factors are also influenced by several other parameters, including fuel formulations, specific scenario conditions, and vehicle fleet characteristics.

MOBILE6 Model

MOBILE6 [26] is a model developed by EPA for the purpose of estimating motor vehicle emission factors. The inputs to MOBILE6 used in the maintenance plan are generally consistent with the CO Attainment Demonstration, although changes have been made when updated information is available or where necessary due to the use of the MOBILE6 model. For example, the MOBILE6 model accepts data on the sulfur content of gasoline whereas the MOBILE5a model did not use such data.

There are a variety of inputs used by the MOBILE6 model. To reflect all vehicles operating in the modeling area requires the weighting of two runs: an Inspection and Maintenance (I/M) run and a non-I/M run. The results from these runs are weighted appropriately to reflect the estimated proportions of I/M and non-I/M vehicles within the nonattainment area. Additionally, the MOBILE6 model was run separately for each of the five area types defined in the modeling area: central business district, urban, urban fringe, suburban, and rural. These area types were modeled separately in order to take into account different speed patterns on roadways in the different area types.

Additionally, local data such as details of the inspection and maintenance program, local fleet vehicle registration data, fractions of the vehicle fleet that are diesel powered, episode specific temperatures, and gasoline properties are included in the data input to MOBILE6.

Emission factors from the MOBILE6 model are unique to each hour of the day and reflect a unique temperature for the modeling domain for the given hour. The output from the MOBILE6 model includes emission factors by vehicle class, vehicle age, facility type, and hour. These emission factors are utilized by the M6Link program in estimating onroad motor vehicle emissions for the MAG region.

M6Link System

The M6Link system is a series of two FORTRAN-based programs that integrates travel demand modeling output and emission factors from MOBILE6 to produce estimates of total onroad vehicle emissions. The vehicle travel component of M6Link reads in the output from the travel demand models that are processed through GIS software. The output from the travel demand models reflect four times of day; a.m. peak, midday, p.m. peak, and nighttime. The outputs also reflect four vehicle classes; light duty commercial vehicles, medium duty commercial vehicles, heavy duty commercial vehicles, and all other vehicles. Other components of the data produced by the travel demand models are the coordinates of each modeled roadway link and individualized traffic estimates for that link, the facility type of the link, the area type, and more.

The vehicle travel component of M6Link reads in data produced from the travel demand models and produces vehicle miles traveled (VMT) estimates that have been changed from being link-specific to grid cell specific. The estimates have also been converted from reflecting a total for the four time periods of the day to hourly estimates.

In this component of M6Link, Highway Performance Monitoring System (HPMS) factors are applied to reconcile VMT generated by the EMME/2 travel demand models with actual VMT reported by HPMS. HPMS data for the State is submitted annually to the Federal Highway Administration by the Arizona Department of Transportation. Actual HPMS VMTs for 1994 and 1995 were used to convert EMME/2 modeled VMT to HPMS-consistent values. Appendix III-iv describes the procedure used to develop HPMS factors for years after 1997 (i.e., 2015). Reconciliation of travel demand modeled VMT with HPMS is a practice recommended by EPA [31].

All VMT estimates contained in the travel demand model are generated for an average weekday. To take into account traffic volumes for a specific episode day, adjustment factors consistent with those used in the Serious Area Plan are calculated and used to convert the "typical" weekday traffic volumes into volumes for a Friday-Saturday in December. The adjustment factors of 0.9168 for December, and 1.0405 for Friday and 0.8280 for Saturday, are multiplied to yield an adjustment factor of 0.9539 for a Friday in December and 0.7591 for a Saturday in December.

The highway network VMT data, created with the EMME/2 transportation model, that is read in by M6Link re-emerges from M6Link in the form of a VMT table. This VMT table includes the estimated VMT for each grid cell, for each hour, and for each combination of area type, facility type, and vehicle class. This file includes individual VMT estimates for approximately two million area type/hour/vehicle class/grid cell/facility type combinations. Each of these VMT estimates is combined with an emissions factor (in grams per VMT) in the second portion of M6Link.

There are several inputs required by the emissions portion of M6Link. In addition to the very detailed outputs of the vehicle travel component of M6Link, other inputs include the emission factor outputs from MOBILE6 in the database format, a job file that includes information such as the year that is being modeled and the names of the MOBILE6 files to use, and a file that assists in converting the 28 vehicle classes considered by the MOBILE6 model into the four classes included in the travel demand models.

Like the vehicle travel component of M6Link, the emissions component of M6Link performs several tasks. The MOBILE6 outputs that reflect the I/M scenario and the outputs that reflect the non-I/M scenario reside in different electronic files. The program reads in the I/M and non-I/M emission factor for each scenario and weights them internally to produce a single emission factor for each area type/vehicle type/facility type/hour combination. The program also combines the emission factors from the 28 vehicle classes produced by MOBILE6 into the four vehicle classes produced by the travel demand models.

Additionally, while the MOBILE6 model produces estimates of cold starts emission factors independent of facility type, cold start emissions are generally more likely to occur on smaller roadways such as arterials and local roadways. It is unlikely that vehicles would produce cold start emissions while on a freeway since it would generally take several minutes to reach a freeway from where the vehicle had been at rest (such as a home or workplace). As such, cold start emissions have been applied to all roadway types except for freeways and freeway ramps to improve the spatial allocation of these emissions.

Using the emission factors output by MOBILE6, M6Link calculates and spatially allocates the onroad mobile emissions in the modeling domain. The hourly emissions output from M6Link is processed through MEDEXPLORA to provide UAM-ready input files. Control measures that result in across-the-board adjustments are applied to the UAM-ready input files through the EMSCOR utility.

The temporal distribution of the CO emissions by source category for Friday, December 16, 1994 is shown in Figure III-1. The spatial allocation of the onroad mobile source CO emissions for Friday, December 16, 1994 is shown in Figure III-2. The maximum emission density from onroad vehicles occurs at grid cell (12,21).

III-1-2 BACKGROUND EMISSIONS

Background emissions are defined as all CO emissions except those from onroad mobile sources. The background emissions include point sources, area sources such as wood burning fireplaces, and nonroad mobile sources. For this modeling analysis, the nonroad mobile source category includes aviation and locomotive emissions, in addition to gasoline and diesel-powered equipment, ranging from lawn and garden to construction equipment.

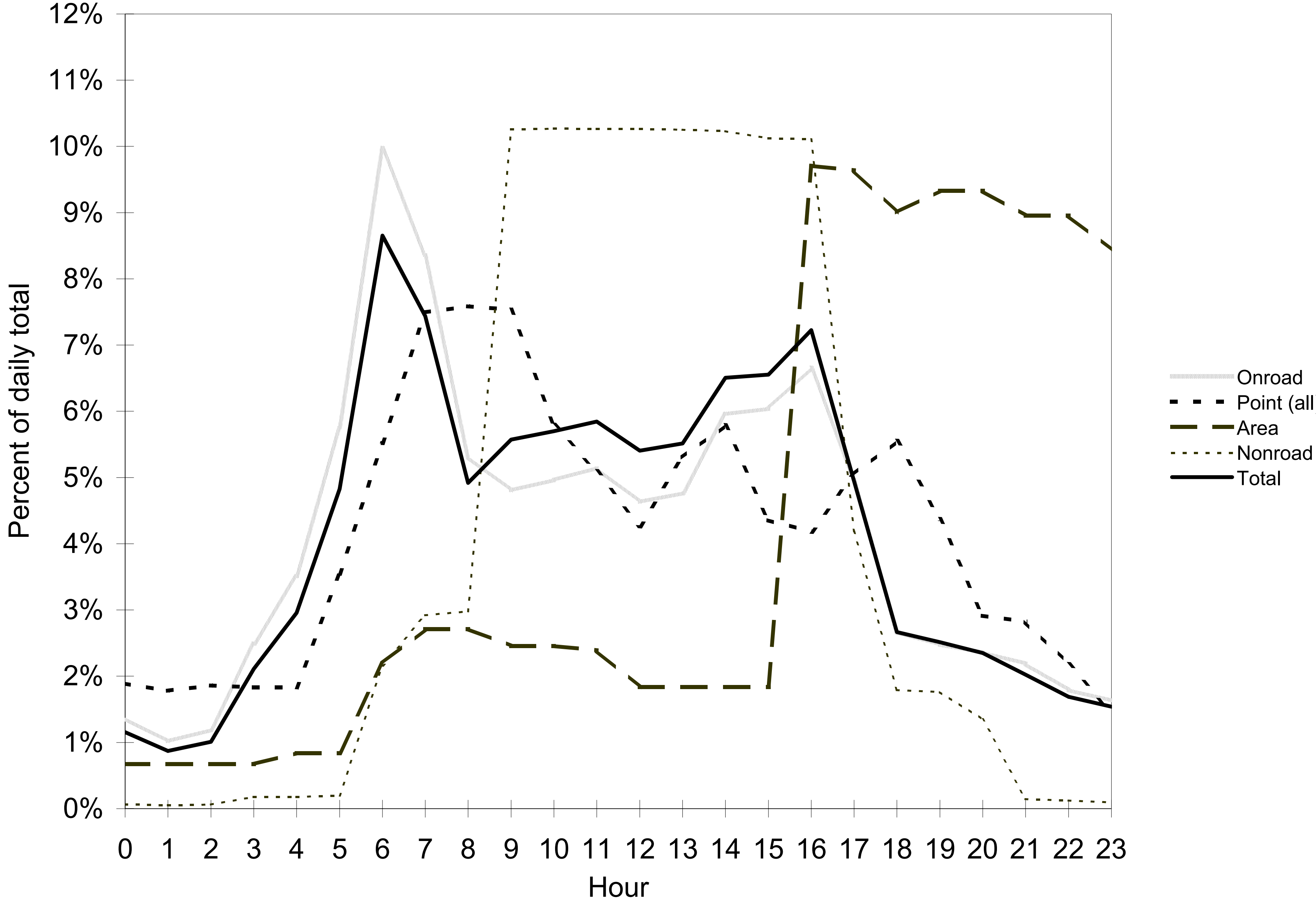


FIGURE III-1. Temporal distribution of emission sources for Friday, December 16, 1994.

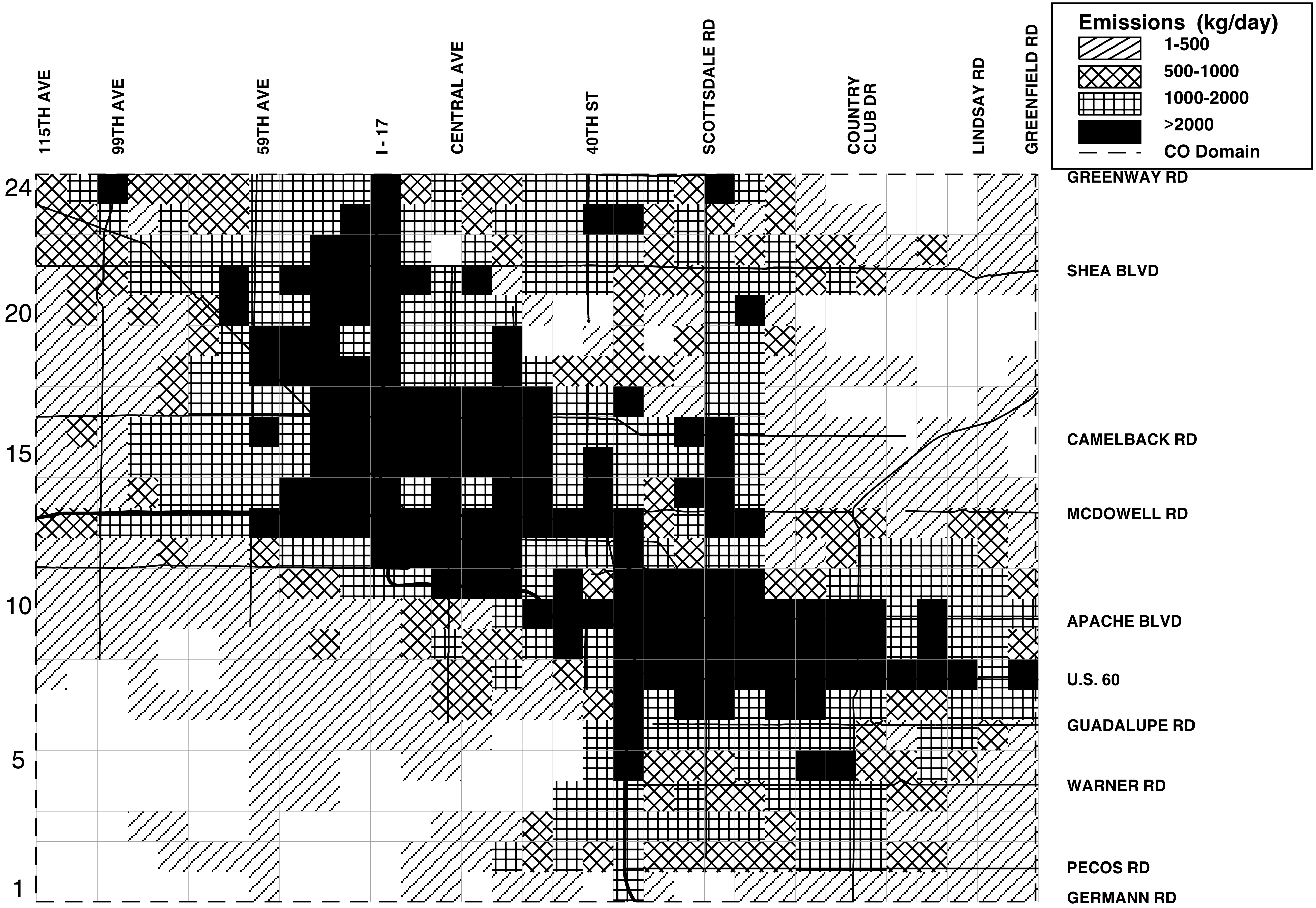


FIGURE III-2. CO onroad mobile source emissions for Friday, December 16, 1994
Maximum Value = 6,946 kg/day at (12,21). Total = 869,592 kg/day

The modeling inventory for base year 1994 was projected from the 1993 periodic emissions inventory [14]. Additional details about the base year modeling inventory development may be found in appendices volume two Appendix II of the Revised CO TSD [11].

The UAM Emissions Preprocessor System (EPS2.0) [2] is an EPA model available for developing background emission estimates. EPS2.0 provides a series of modules into which locally derived or default data are input with the final result being emission factor files appropriate for use in the Urban Airshed Model. To improve the data available for input to the EPS2.0 system, several studies were conducted. This section will first discuss studies that were performed to develop locally-specific data, and will then discuss the EPS2.0 system itself.

Aviation Emissions

The aviation emission estimates were obtained from the MAG Aviation Emissions Preprocessor, described in the report by Lee Engineering (November 1996) [5]. Airport activity levels were based on surveys conducted at each airport which included questions about aircraft activity, ground service vehicle use, fuel use, and coating operations. The activity data for the preprocessor were collected through airport surveys conducted in 1995 which is the base year for the preprocessor. Emission factors for estimating aircraft emissions were calculated using the FAA Aircraft Engine Emissions Database (FAEED) and were supplemented with emission factors not included in the FAEED database, based upon EPA guidance [25]. The preprocessor also adjusts emission estimates based upon episode-specific mixing heights and includes an algorithm which improves estimates of time-in-mode during busy periods.

Four airports are located within the CO modeling domain: Glendale Municipal, Scottsdale Municipal, Sky Harbor International, and Stellar Airpark. Emission totals from aviation-related sources at these airports are estimated using the MAG Aviation Emissions Preprocessor (Lee Engineering, 1996) [5]. The aviation-related sources include both emissions from aircraft, which are estimated on an hourly basis, and ground service vehicles, which are estimated on a daily basis. There are no CO emissions from refueling or fuel storage activities in the preprocessor output. The hourly emissions from aircraft and daily emissions from ground service vehicles are assigned to links for further processing in the EPS2.0 LBASE program. Table III-1 provides a summary of the aviation-related emissions by airport for the CO modeling domain.

Residential Wood Combustion

The development of the residential wood combustion (RWC) emission estimates is described in the Revised CO TSD [11]. The RWC emissions were calculated based on a local survey [32] of activity levels which included woodburning fireplaces, woodstoves, and woodburning barbeques/firepits. These activity levels were combined with emission factors for estimating emissions from residential wood combustion obtained from AP-42. It is important to note that

Table III-1. Summary of the aviation-related emissions by airport for the CO modeling domain.

Airport	Ground Service Vehicles	Aircraft	Total
Sky Harbor	4.36	3.73	8.09
Glendale	0.03	0.82	0.84
Scottsdale	0.40	1.51	1.91
Stellar Airpark	0.03	0.29	0.32

the survey reflects the implementation of the Maricopa County Residential Wood Combustion Ordinance adopted in September 1994.

<u>EPS2.0</u>

The UAM Emissions Preprocessor System (EPS2.0) [2] was used to process the emissions inventories including point, area, aviation, and nonroad mobile sources.

The UAM Emissions Preprocessor System (EPS2.0) consists of a set of FORTRAN programs that are executed sequentially to prepare the gridded emission inventory for use by the UAM. The EPS2.0 is used to process background emissions and to merge the background emissions with the onroad emissions generated by M6Link. The programs are as follows:

PREPNT: Prepares the annual or seasonal point source inventory for further processing; identifies which sources are to be treated as elevated by the UAM.

PREAM: Prepares annual or seasonal area and nonroad mobile source emissions for further processing.

LBASE: Prepares link-based mobile source emission estimates for further processing and disaggregates total emissions into individual components. This module is used only for processing aviation emissions; the onroad mobile processing is done by M6Link.

CNTLEM: Adjusts emission levels to reflect the effects of anticipated growth or implementation of proposed controls.

CHMSPL: Assigns input hydrocarbon emissions to chemical species expected by the chemical mechanism (not used for CO modeling).

TMPRL: Temporally adjusts emissions from annual, seasonal, or typical season day to episodic levels.

GRDEM: Spatially allocates emissions based on source location, link location, or gridded spatial surrogate indicators; converts to a UAM-ready inventory of low-level emissions. The procedure used to derive the surrogate indicators is described in the Serious Area CO Plan [10].

MRGUAM: Merges UAM-ready emissions files for several area, mobile, and low-level point source emission files into one file.

RPRTEM: Summarizes emission totals for the modeling domain by category.

Temporal Allocation of Background Emissions

The EPS2.0 is used to temporally allocate the power plant point source emission data based on the operating schedule provided with the 1993 periodic emissions inventory from the Maricopa County Environmental Services Department (MCESD). All other point sources are resolved temporally based on profiles for seasonal activity, activity provided by day of week, and diurnal patterns of activity. The EPS2.0 uses monthly and day-of-week adjustment factors to convert the point source emissions to episode day values (e.g. a Friday and a Saturday in December). For point source emissions estimates, this information was determined from annual emission inventory reports. These emission inventory reports request seasonal throughput percentages, operating hours per day, days per week in operation, and specific hours of operation.

Nonroad and area source emissions were input to EPS2.0 as annual totals. To convert these values to average December daily values, the EPS2.0 applies an adjustment factor representing the ratio of December emissions to annual emissions for each source type. A day-of-week factor is necessary to convert average day emissions to Friday and Saturday emissions. Area source seasonal data were obtained from the natural gas suppliers for fuel combustion, area source emission inventory reports for incineration, and limits of permits for open burning. Hourly data for area sources provided by MCESD were taken from Table 6-11 of the EPA guidance for emission inventories [19]. As a result of the changes made by the Maricopa County Environmental Services Department (MCESD) in the Draft 1996 Periodic Carbon Monoxide Emission Inventory [15], MAG updated the nonroad mobile source temporal factors in EPS2.0 with the California Air Resource Board (CARB) temporal factors. Additional details about the nonroad temporal factors may be found in the Revised CO TSD [11].

A few diurnal profiles were based on data obtained from sources other than MCESD or CARB . The diurnal allocation of aircraft emissions was provided by the Aviation Emission Preprocessor. The diurnal profile for residential wood combustion is based on data from the MAG residential wood combustion survey conducted in support of the 1994 Regional PM-10 Emissions Inventory [15]. The temporal distribution of point, area, and nonroad mobile emissions, as well as total emissions, are shown in Figure III-1.

Spatial Allocation of Background Emissions

Point sources are spatially allocated on the basis of the location (UTM coordinates or latitude/longitude) of each source. Area and nonroad mobile source emissions, with the exception of aviation-related emissions, are spatially distributed based on surrogate factors that indicate emission level or activity. For this analysis, projections based on U.S. Bureau of Census population data (1990) and MAG land use data (1990) have been used to determine the spatial allocation factors for all of the area and nonroad mobile sources except for aviation. Figures III-3A through III-3M show the areal distribution of the spatial surrogates used in this study.

Figures III-4 through III-7 illustrate the spatial distribution of the point, area, nonroad, and total background sources in the CO modeling domain for Friday, December 16, 1994. The maximum background emissions of 4,736 kilograms per day occur in grid cell (18,11). Figure III-8 depicts the spatial distribution of total CO emissions, including point, area, onroad and nonroad emissions, for December 16, 1994. The maximum total CO emissions of 9,965 kilograms per day also occur in grid cell (18,11), located at Central Avenue and McDowell Road. Table III-2 provides a summary of emissions for the December 1994 episode.

III-2. Meteorological Inputs

Meteorological inputs required by UAM include gridded wind fields, surface temperature, and mixing heights. Mixing heights are used to define the turbulent region closest to the ground within which atmospheric properties including pollutants are well mixed. UAM also requires specification of additional domain-scale meteorological parameters including pressure, water vapor concentration, nitrogen dioxide (NO_2) photolysis rate, exposure class, and vertical temperature gradients. For this application, the wind and mixing height fields were prepared using a variety of interpolative and diagnostic techniques which allow explicit use of the observed meteorological data. The meteorological scalars were estimated using observed data. The meteorological input preparation procedures and the resulting meteorological inputs are described in this section. Specification of the region top, which is based on the mixing height estimates, is also described in this section.

III-2-1. MIXING HEIGHTS AND REGION TOP

In typical UAM applications, in which multiple layers are specified to divide the regions above and below the DIFFBREAK, temperature data as a function of altitude are required to determine both the strength (i.e., temperature gradient) and depth of nocturnal inversion. Exposure class (specified in the METSCALARS files) determines the degree of mixing between layers below the DIFFBREAK (within the inversion), whereas the temperature gradient above the DIFFBREAK is used to determine the degree of mixing across the DIFFBREAK and between layers aloft. Further, because the thickness of each UAM layer depends on the specification of the DIFFBREAK height, DIFFBREAK will affect the UAM-calculated concentrations in each of the layers, particularly under conditions of limited mixing across layers. Therefore, concentrations increase as emissions are trapped within decreasing layer depths.

In typical wintertime carbon monoxide episodes, a relatively shallow (several hundred meters) but well-mixed afternoon boundary layer collapses near sunset, and a shallow, intense surface-based temperature inversion grows upwards from the surface below a neutral upper layer. Emissions from onroad mobile and background sources are then effectively trapped within a few tens of meters of the surface in this growing stable layer until sunrise the next morning. Therefore, it is likely that CO concentrations decrease dramatically from the surface to the top of the inversion during typical wintertime carbon monoxide episodes.

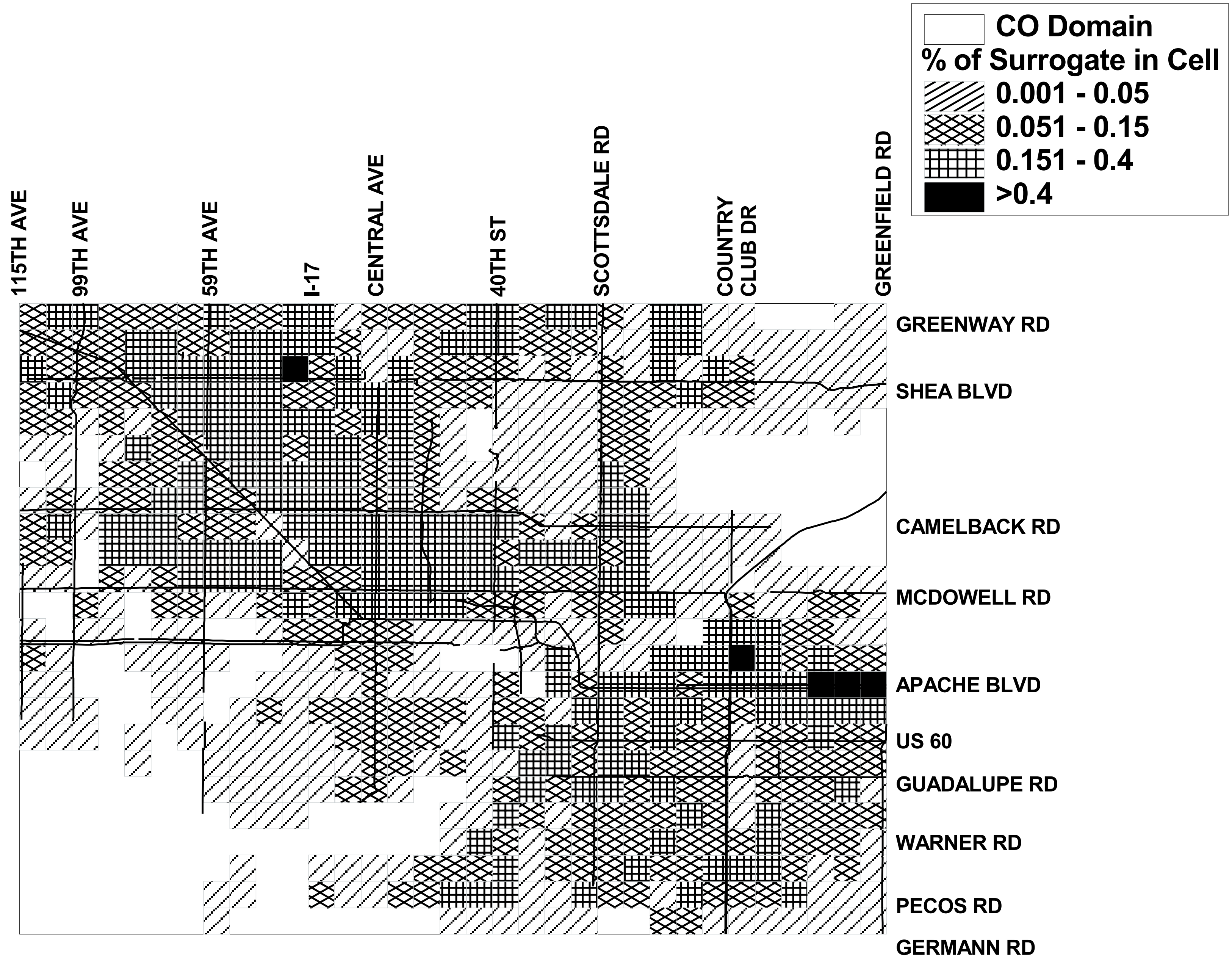


FIGURE III-3A. Maricopa County spatial surrogate - occupied housing (percentages reflect fraction of total in Nonattainment Area)

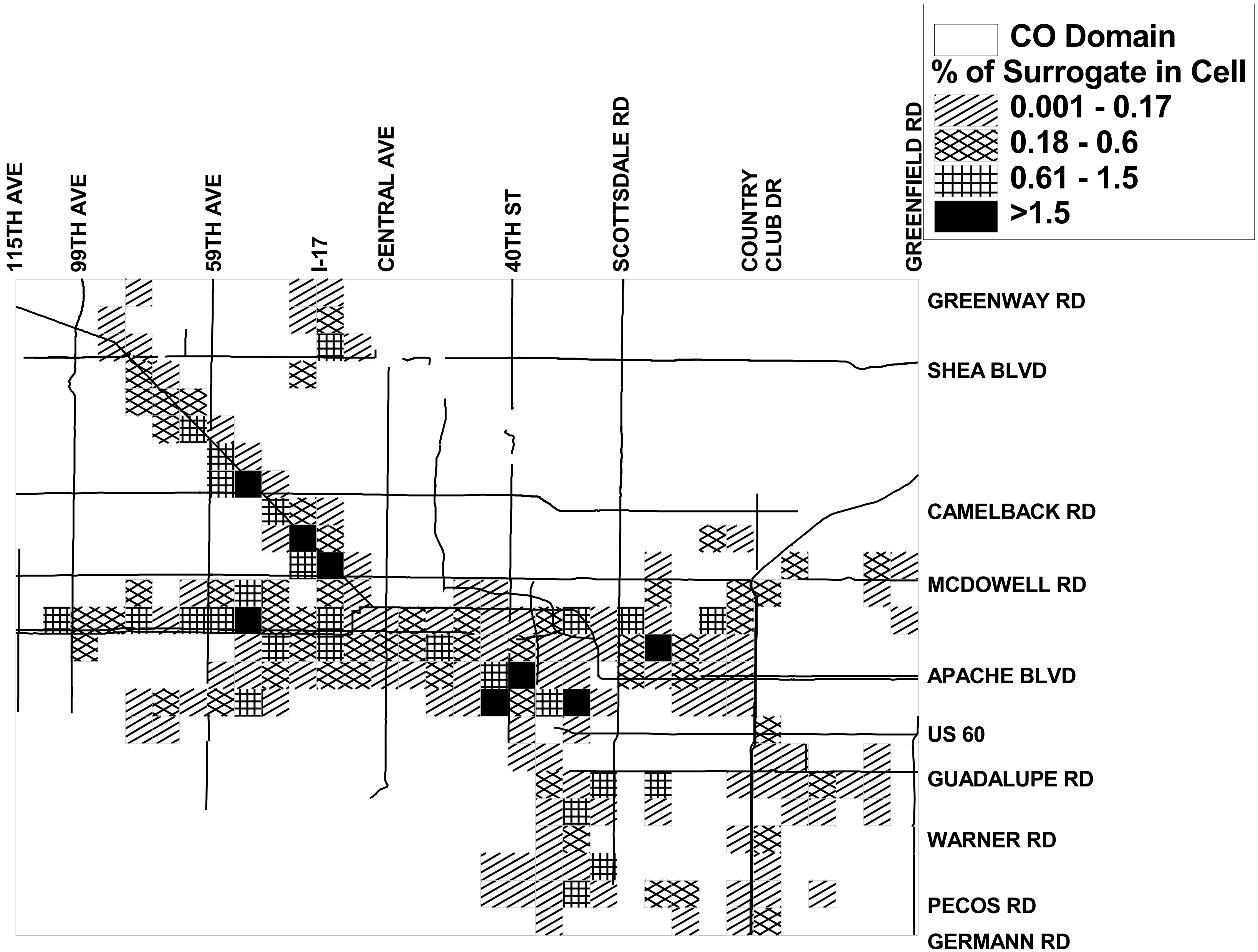


FIGURE III-3B. Maricopa County spatial surrogate - industrial (percentages reflect fraction of total in Nonattainment Area)

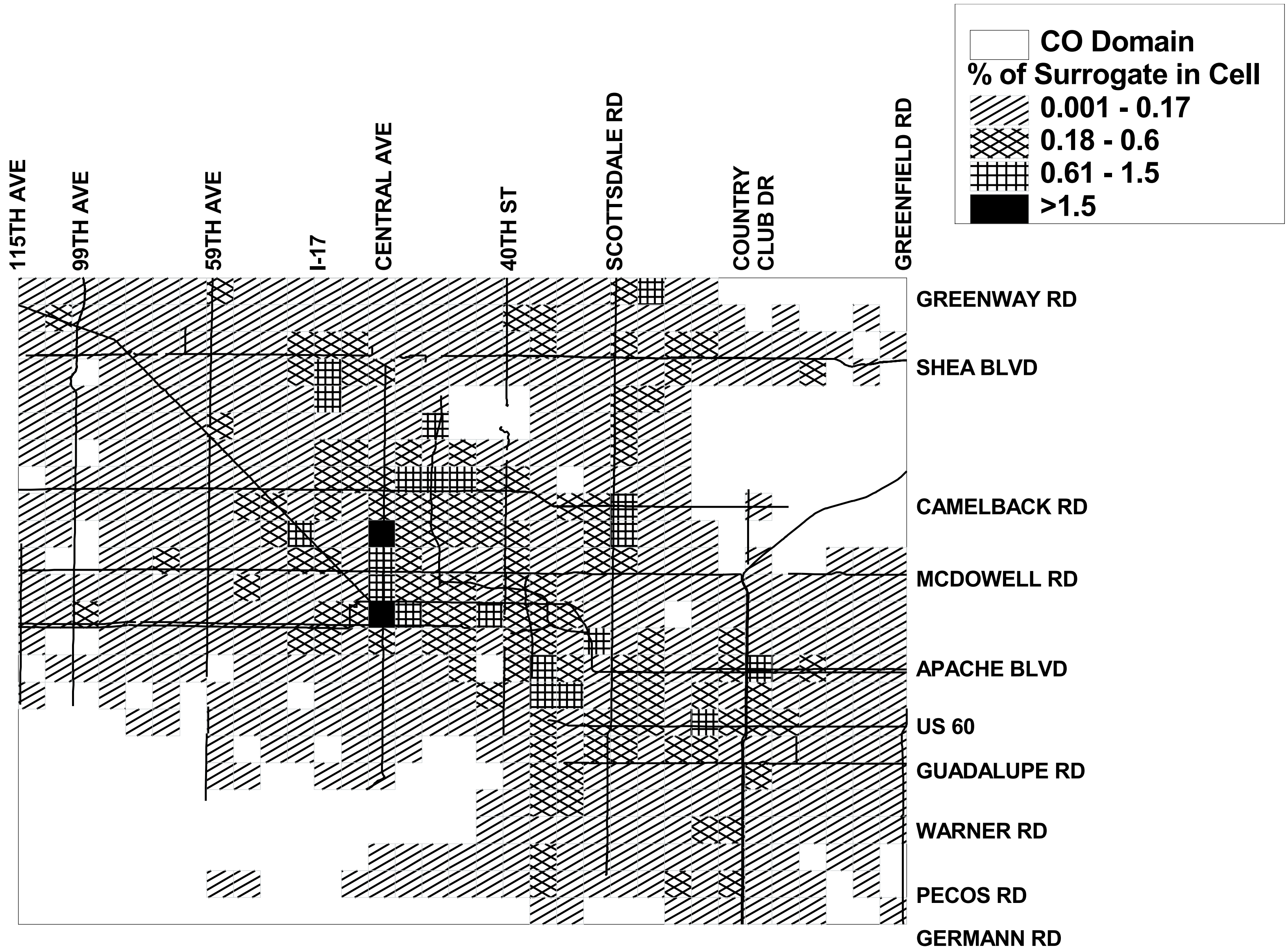


FIGURE III-3C. Maricopa County spatial surrogate - non-industrial (percentages reflect fraction of total in Nonattainment Area)

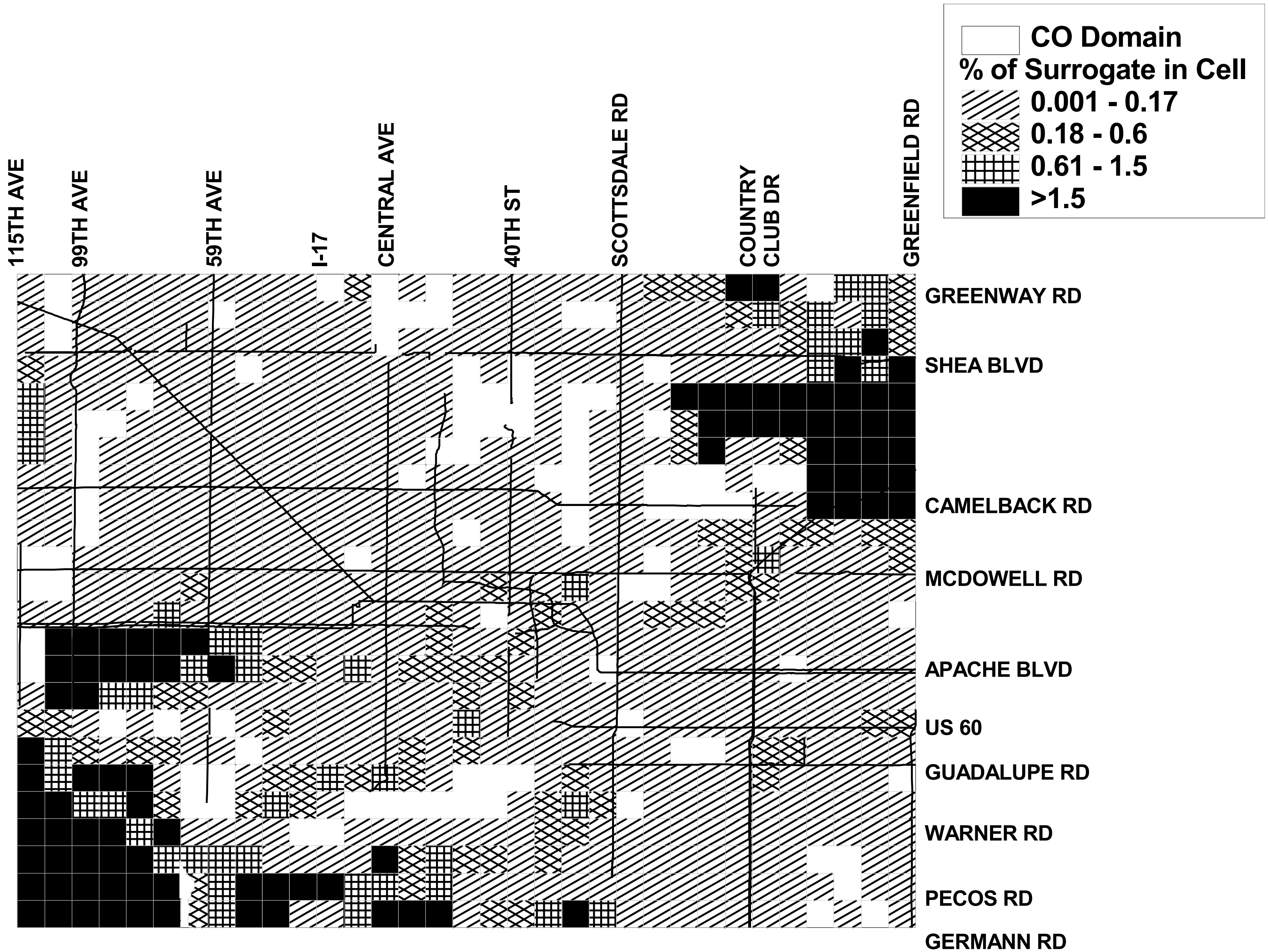


FIGURE III-3D. Maricopa County spatial surrogate - undeveloped total (percentages reflect fraction of total in Nonattainment Area)

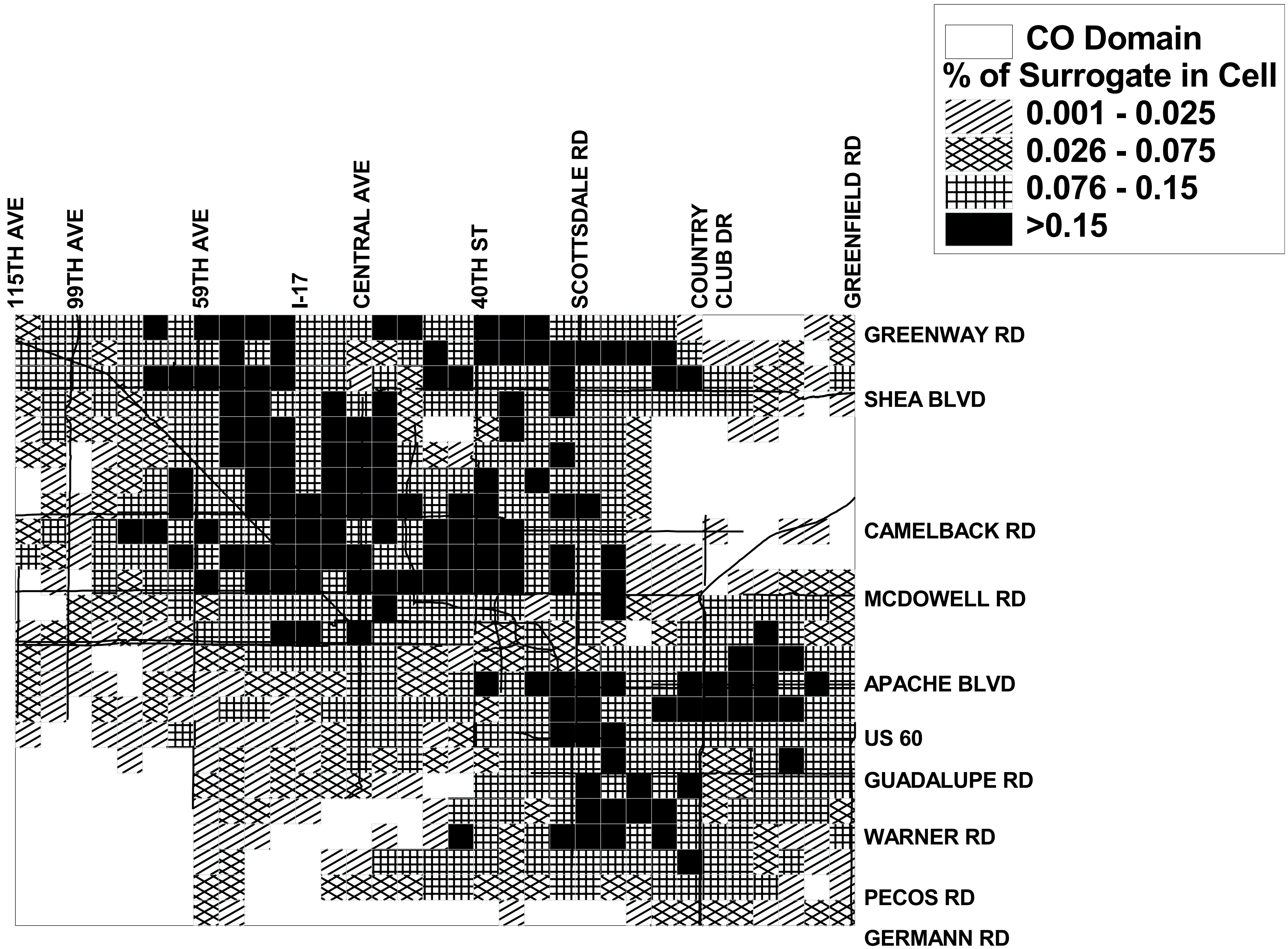


FIGURE III-3E. Maricopa County spatial surrogate - developed total (percentages reflect fraction of total in Nonattainment Area)

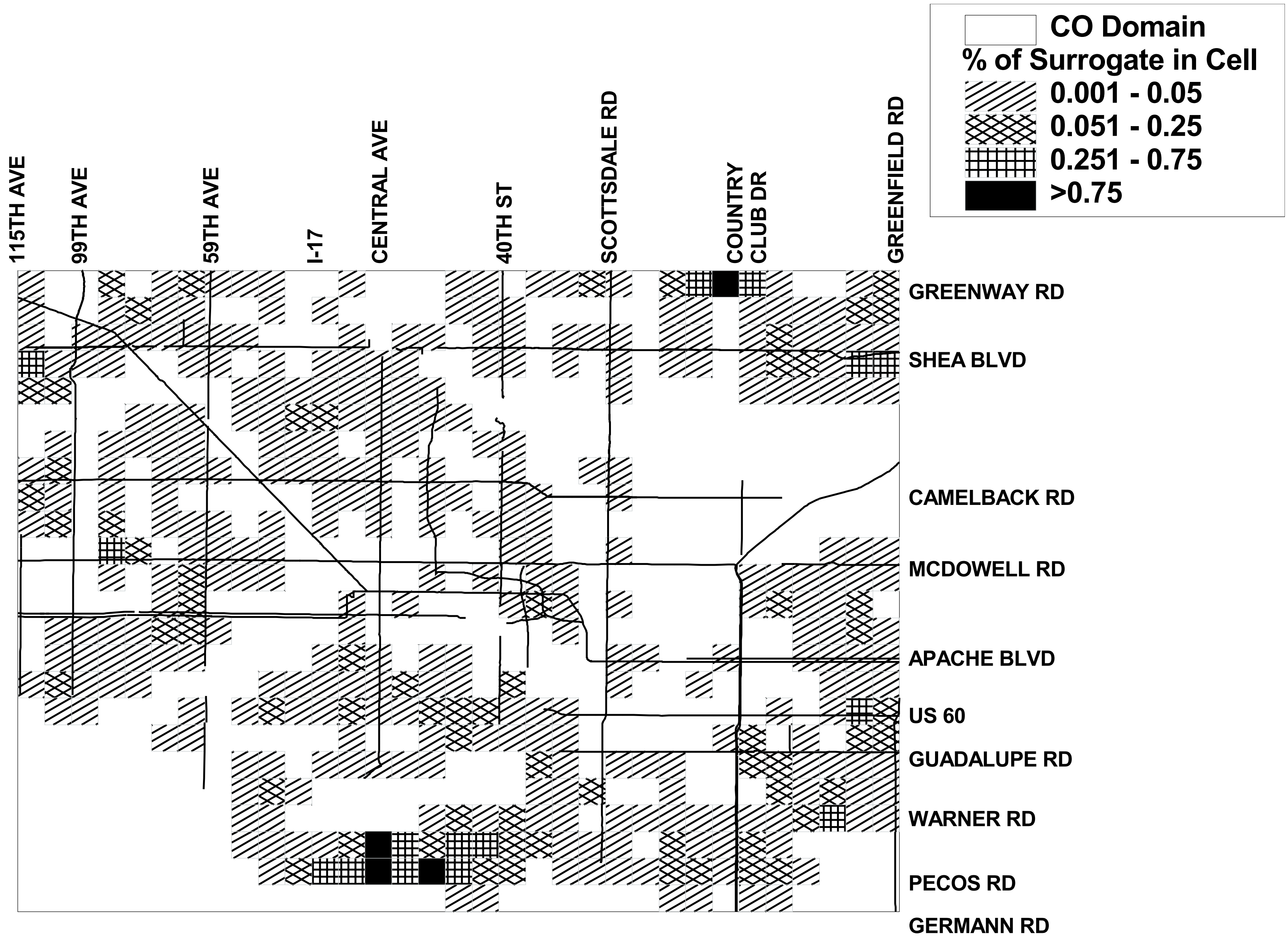


FIGURE III-3F. Maricopa County spatial surrogate - residential construction (percentages reflect fraction of total in Nonattainment Area)

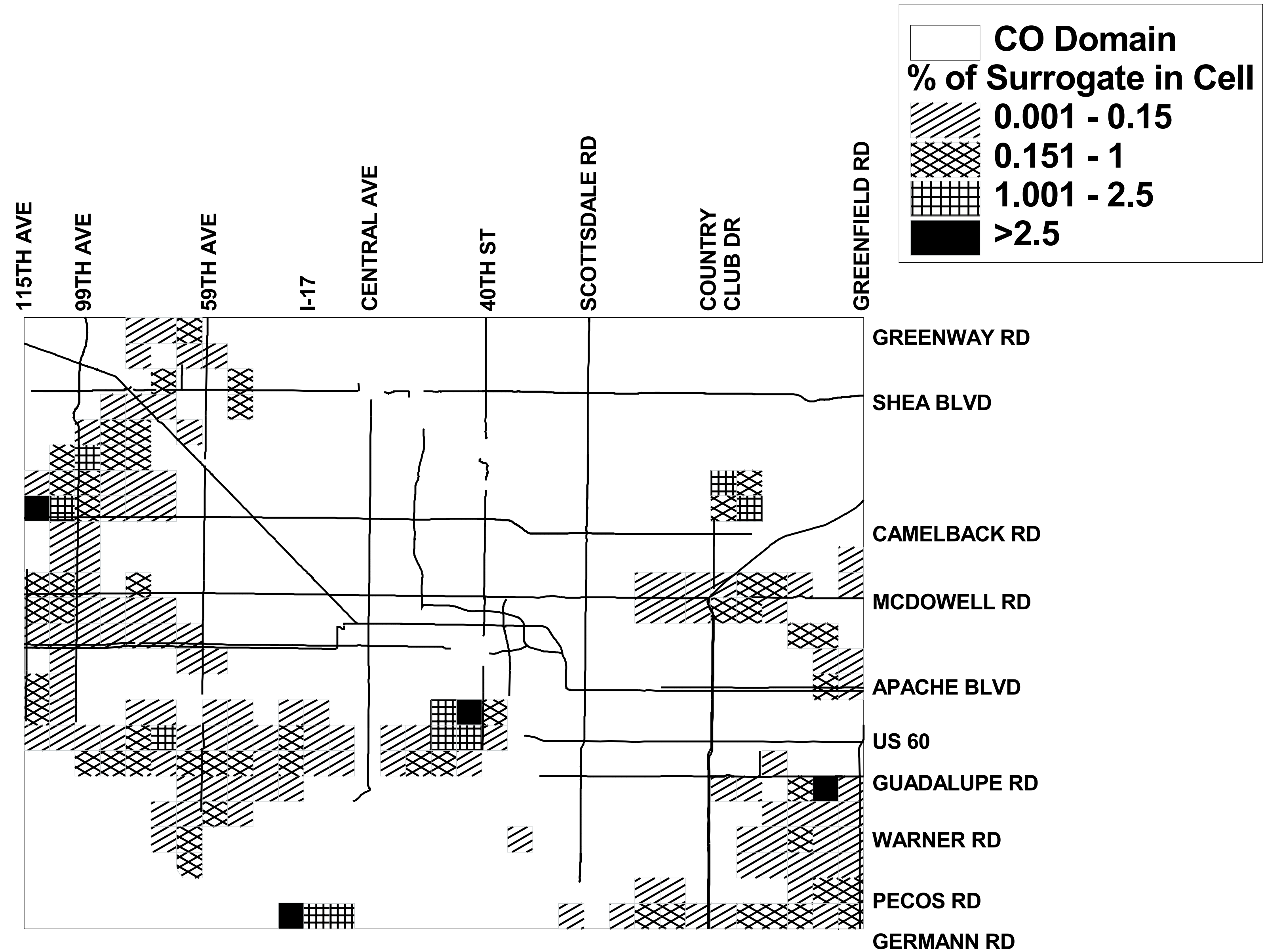


FIGURE III-3G. Maricopa County spatial surrogate - agricultural stockyards (percentages reflect fraction of total in Nonattainment Area)

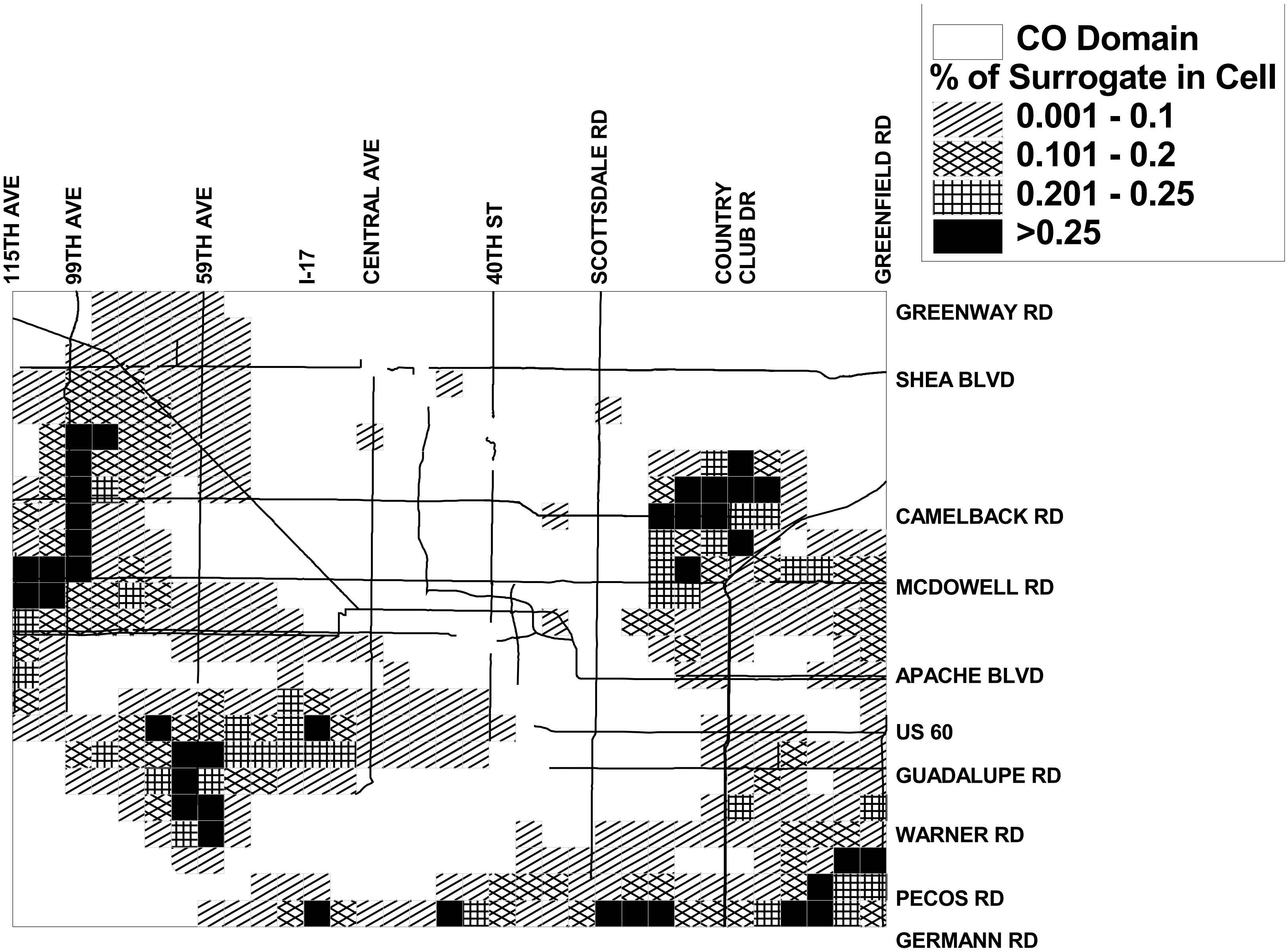


FIGURE III-3H. Maricopa County spatial surrogate - agricultural other (percentages reflect fraction of total in Nonattainment Area)

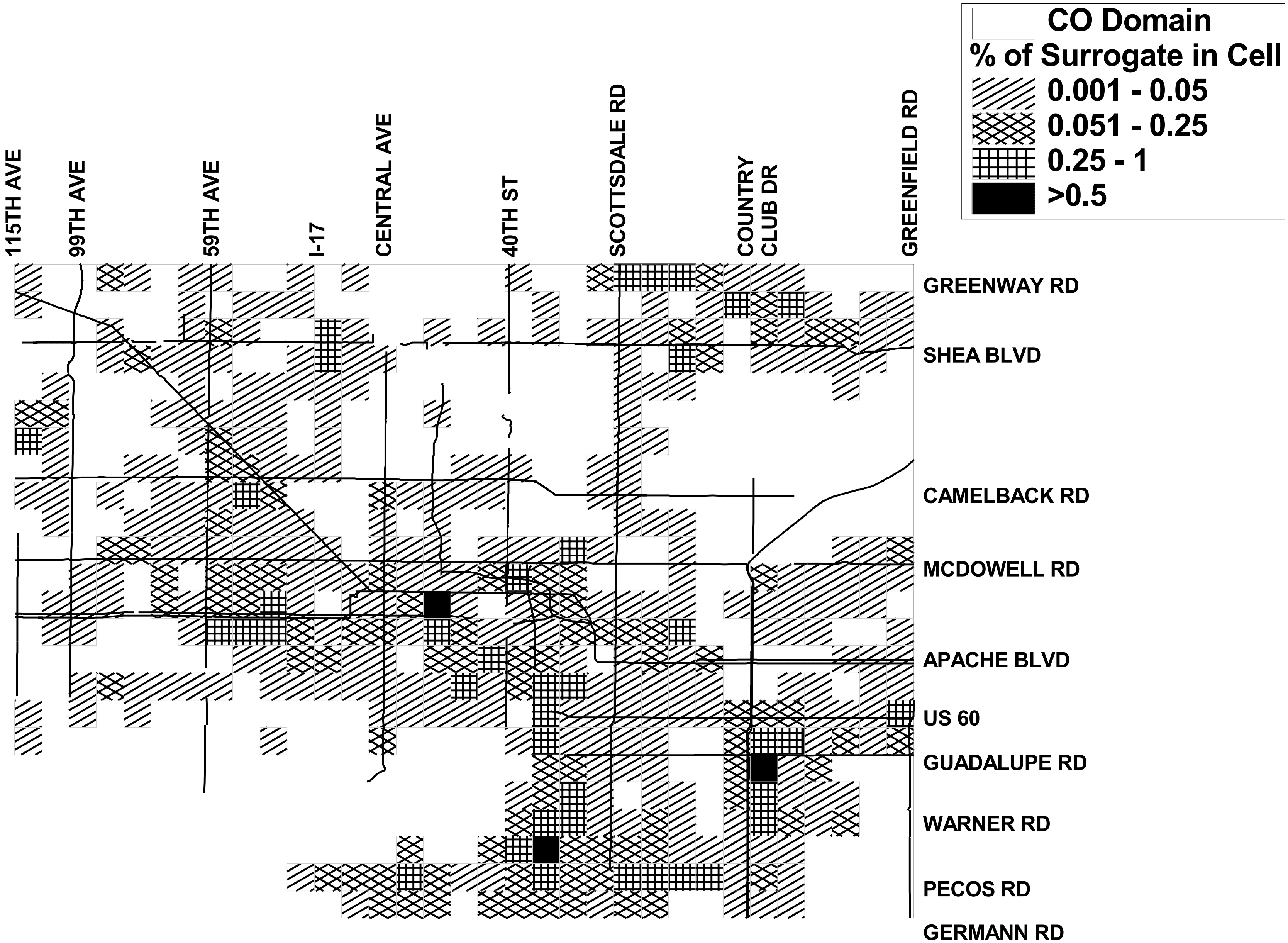


FIGURE III-3l. Maricopa County spatial surrogate - commercial construction (percentages reflect fraction of total in Nonattainment Area)

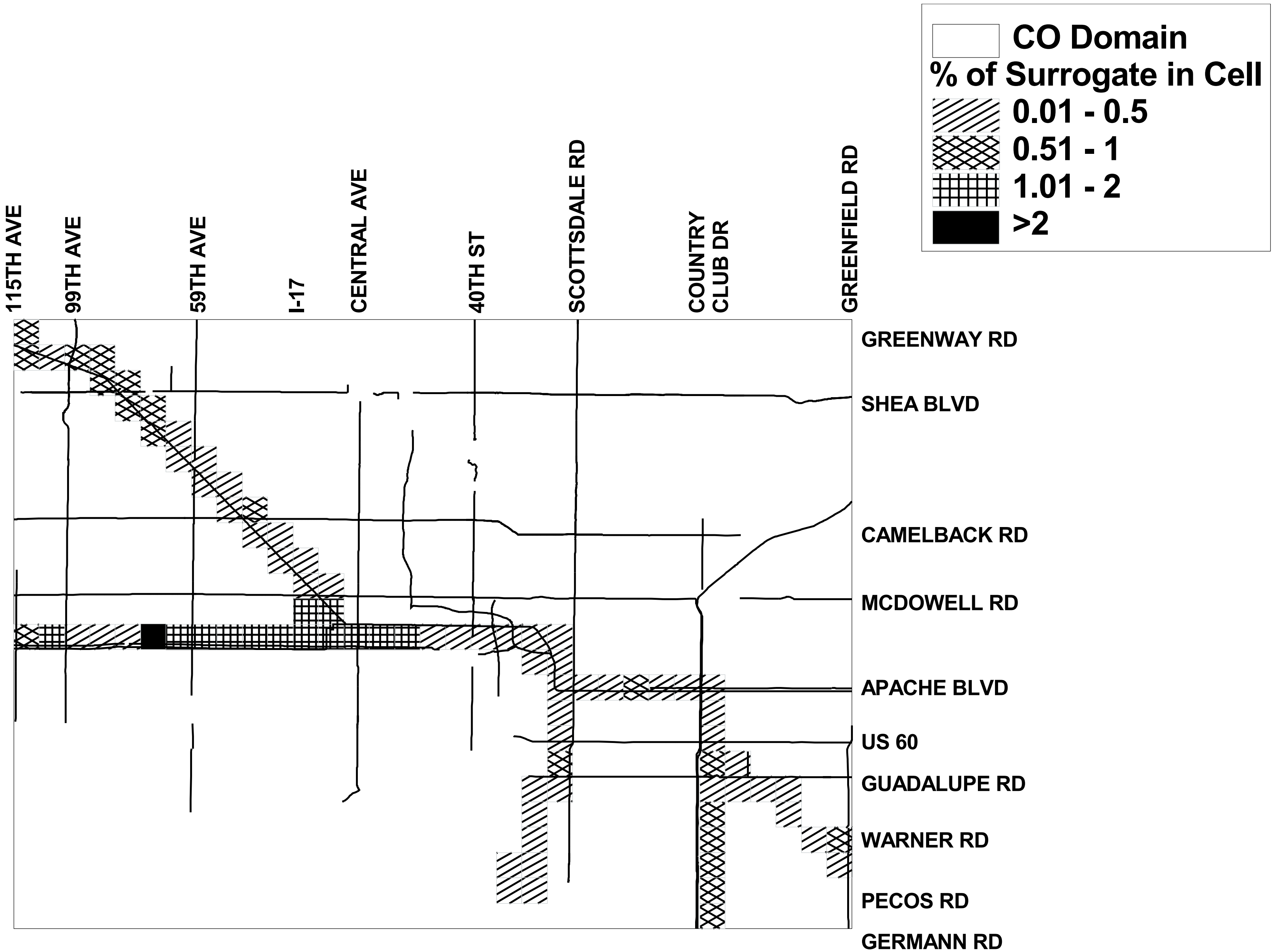


FIGURE III-3J. Maricopa County spatial surrogate - railroad (percentages reflect fraction of total in Nonattainment Area)

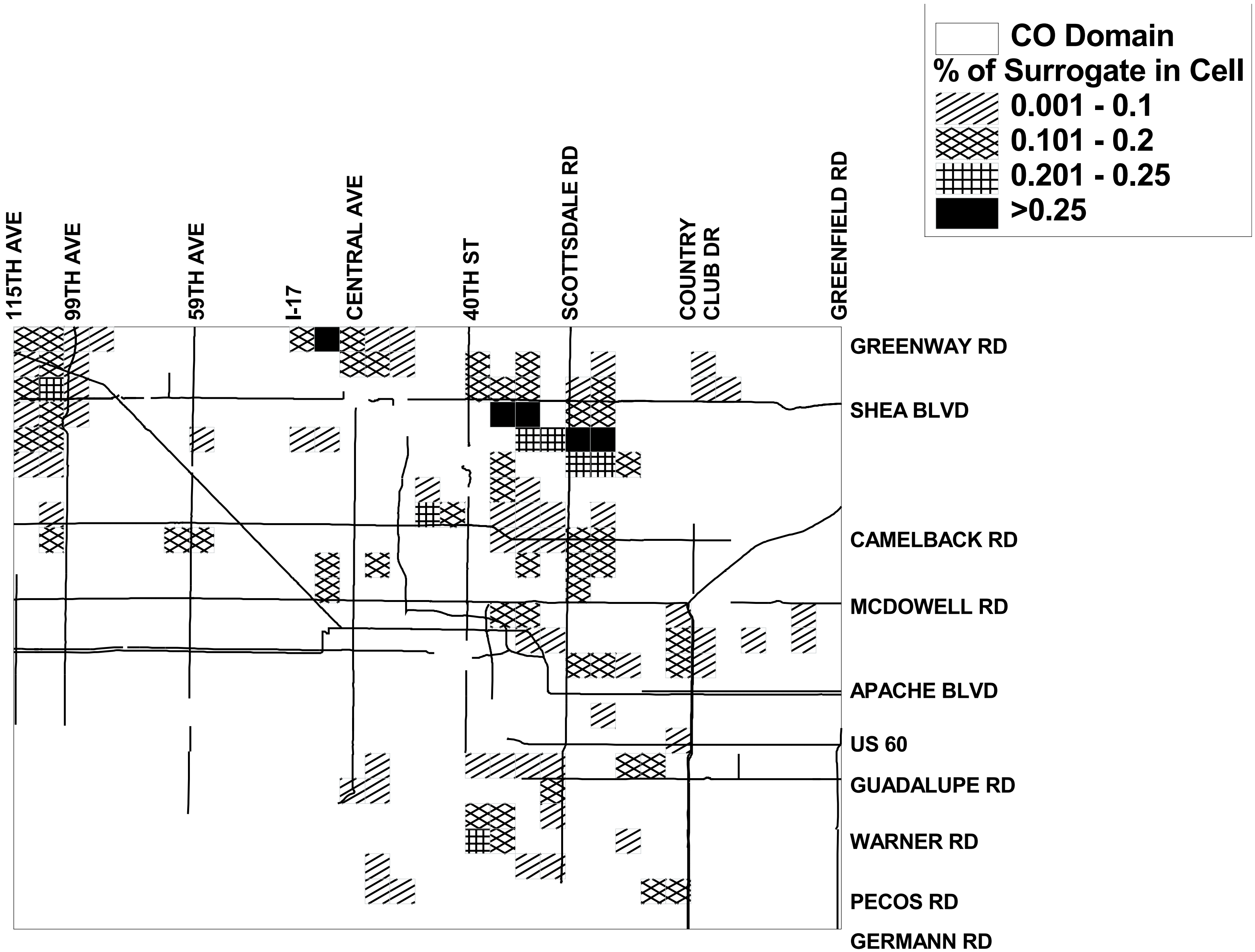


FIGURE III-3K. Maricopa County spatial surrogate - golf course (percentages reflect fraction of total in Nonattainment Area)

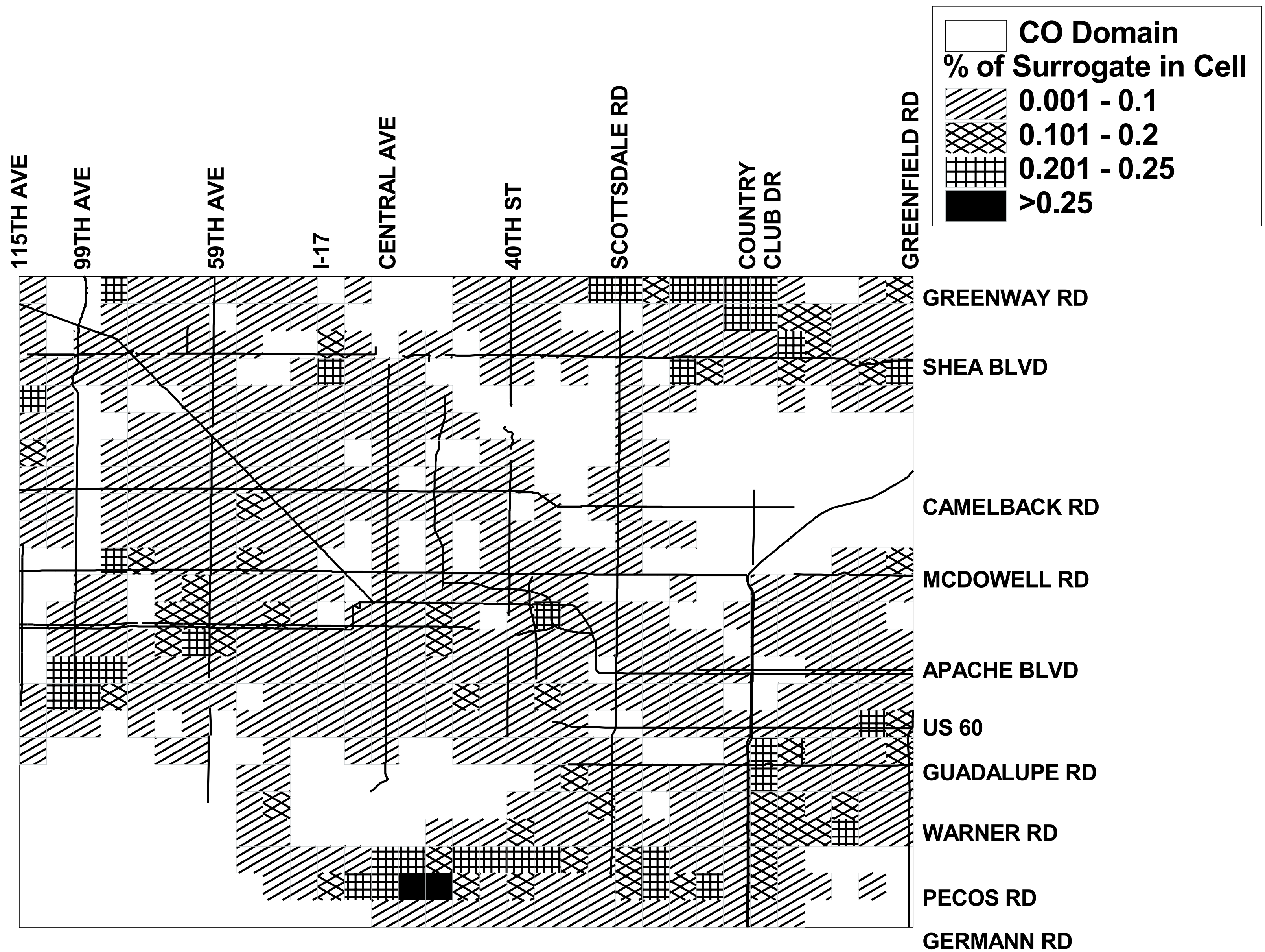


FIGURE III-3L. Maricopa County spatial surrogate - total construction (percentages reflect fraction of total in Nonattainment Area)

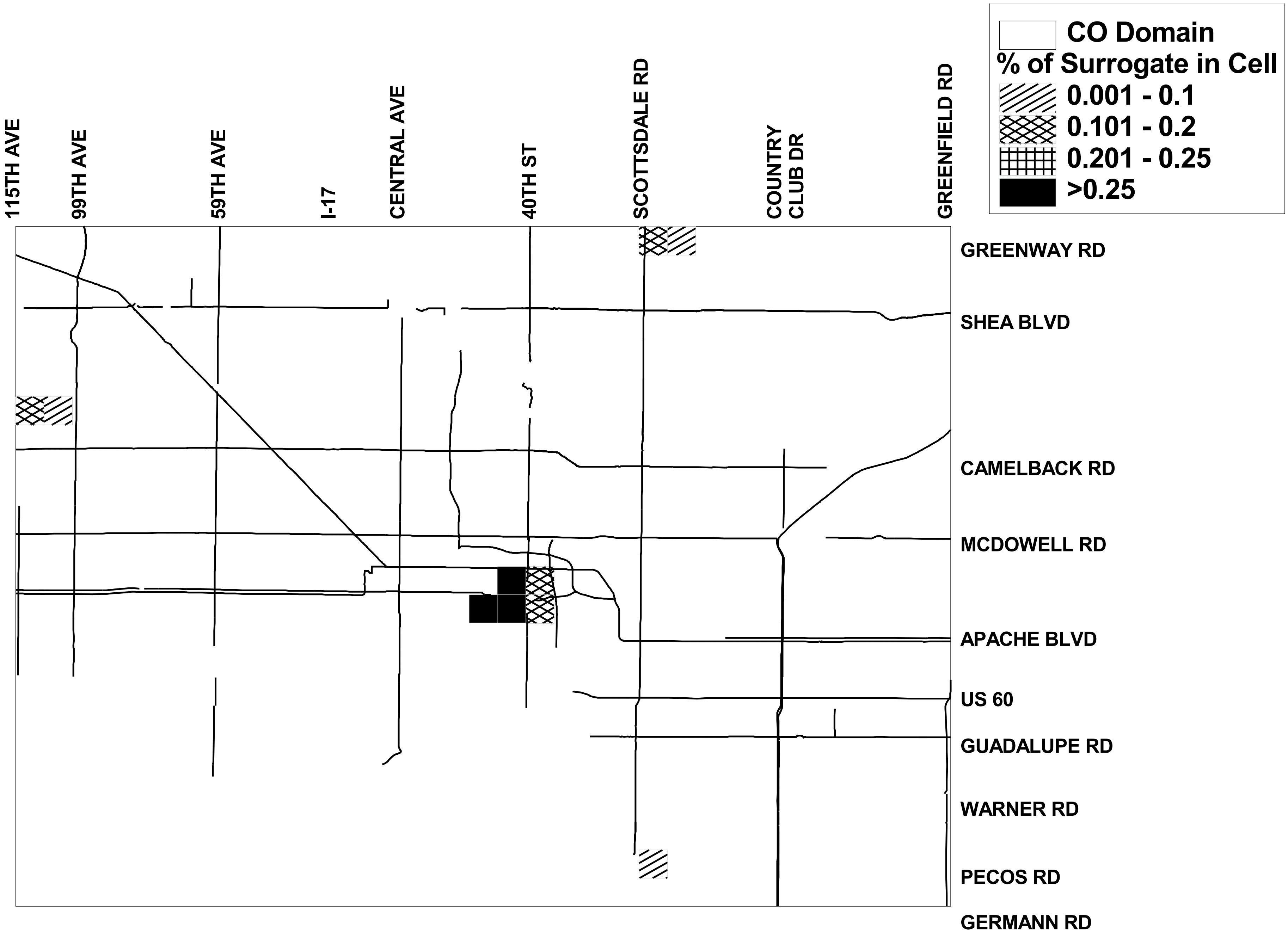


FIGURE III-3M. Maricopa County spatial surrogate - airports (percentages reflect fraction of total in Nonattainment Area)

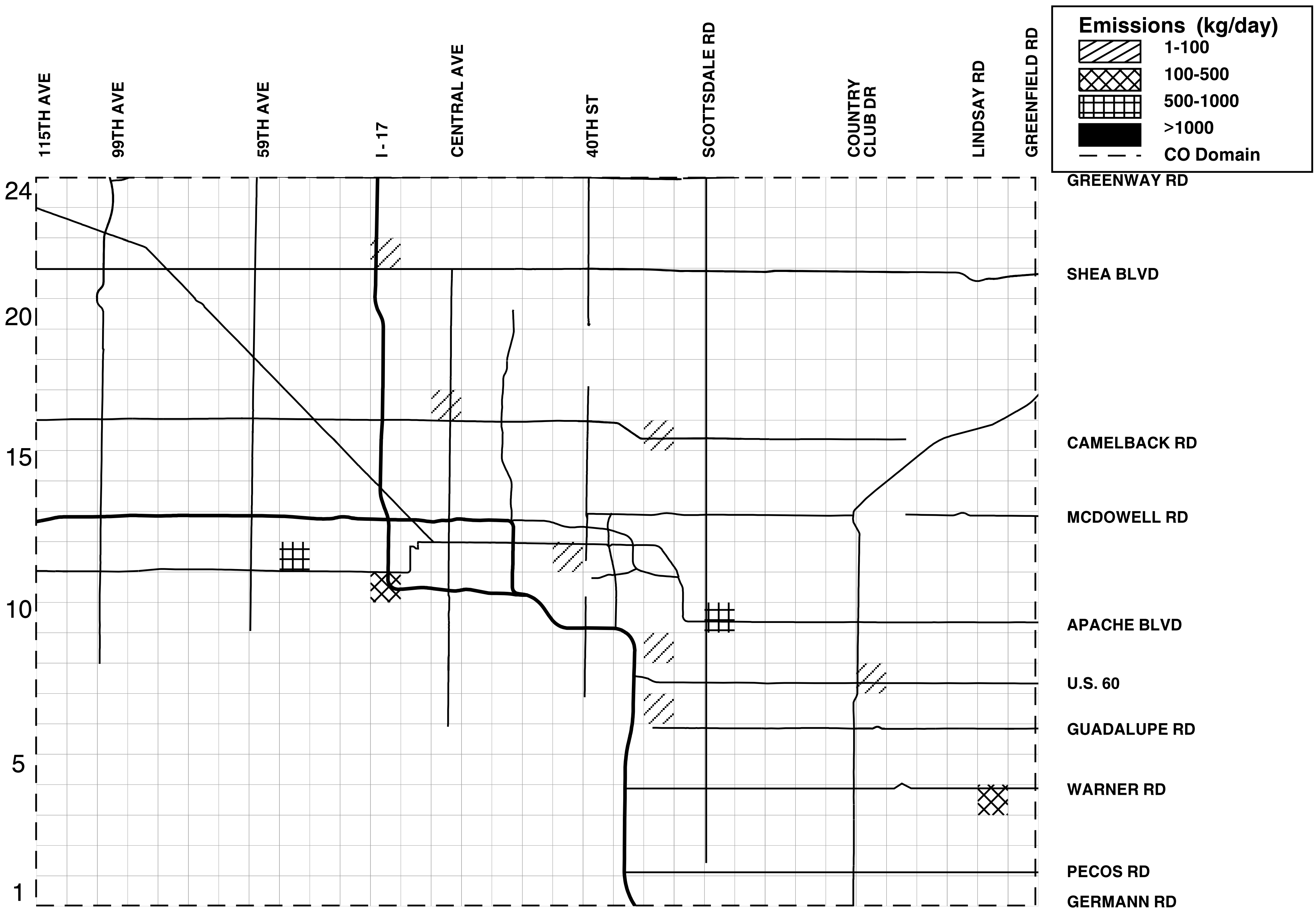


FIGURE III-4. CO point source emissions for Friday, December 16, 1994
Maximum Value = 807 kg/day at (9,12). Total = 2,463 kg/day

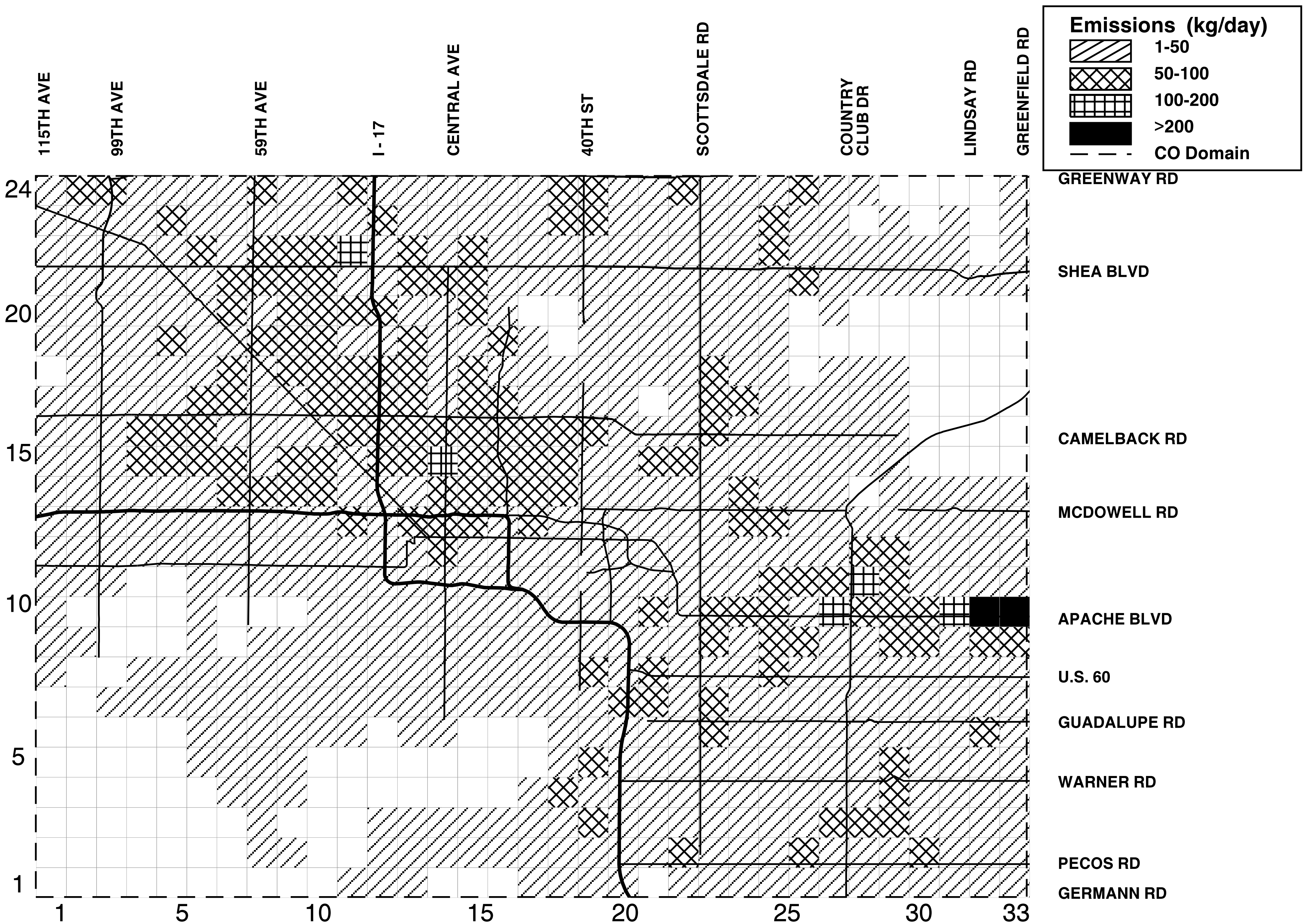


FIGURE III-5. CO area source emissions for Friday, December 16, 1994
Maximum Value = 282 kg/day at (32,10). Total = 21,020 kg/day

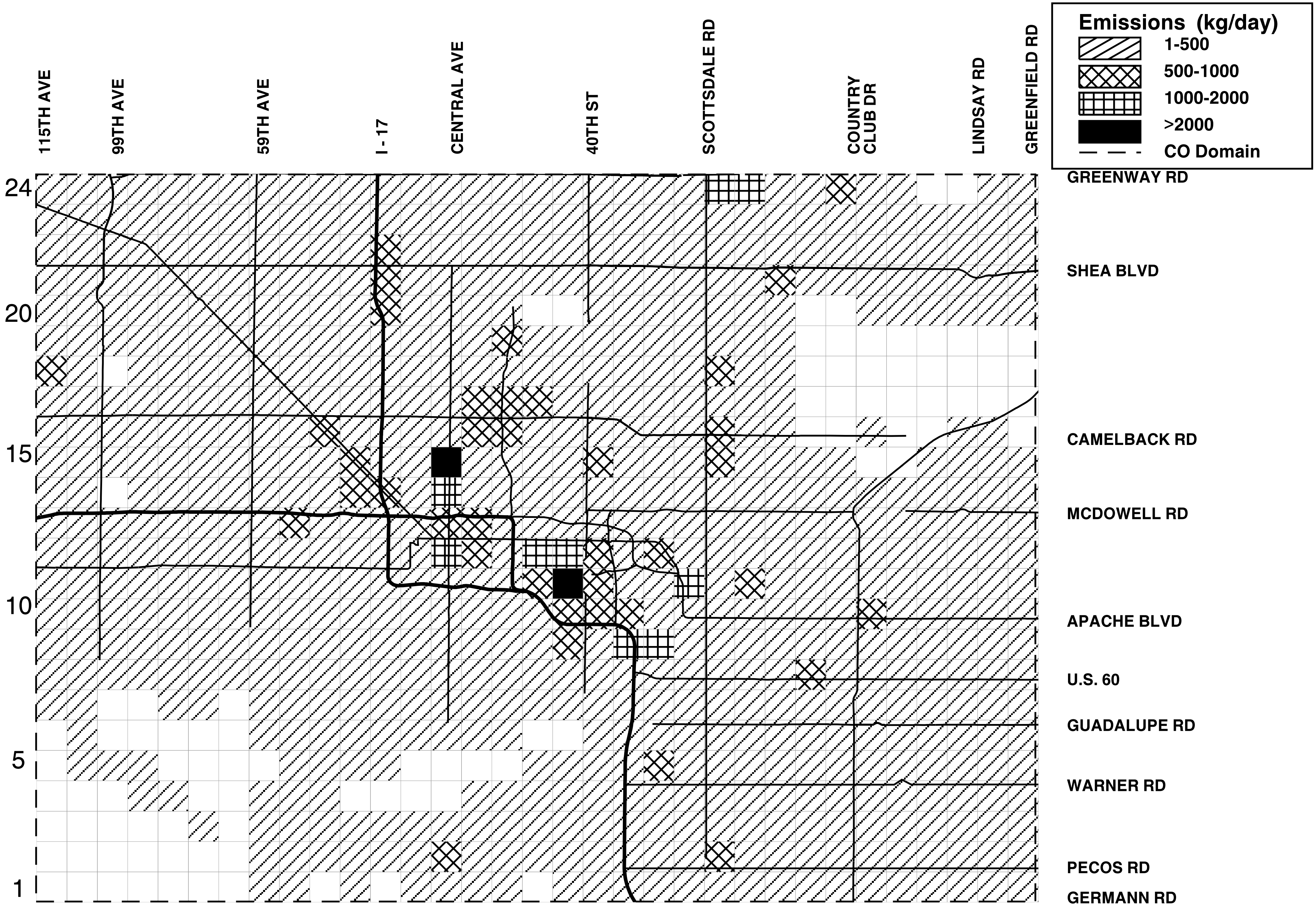


FIGURE III-6. CO nonroad source emissions for Friday, December 16, 1994
Maximum Value = 4,734 kg/day at (18,11). Total = 155,090 kg/day

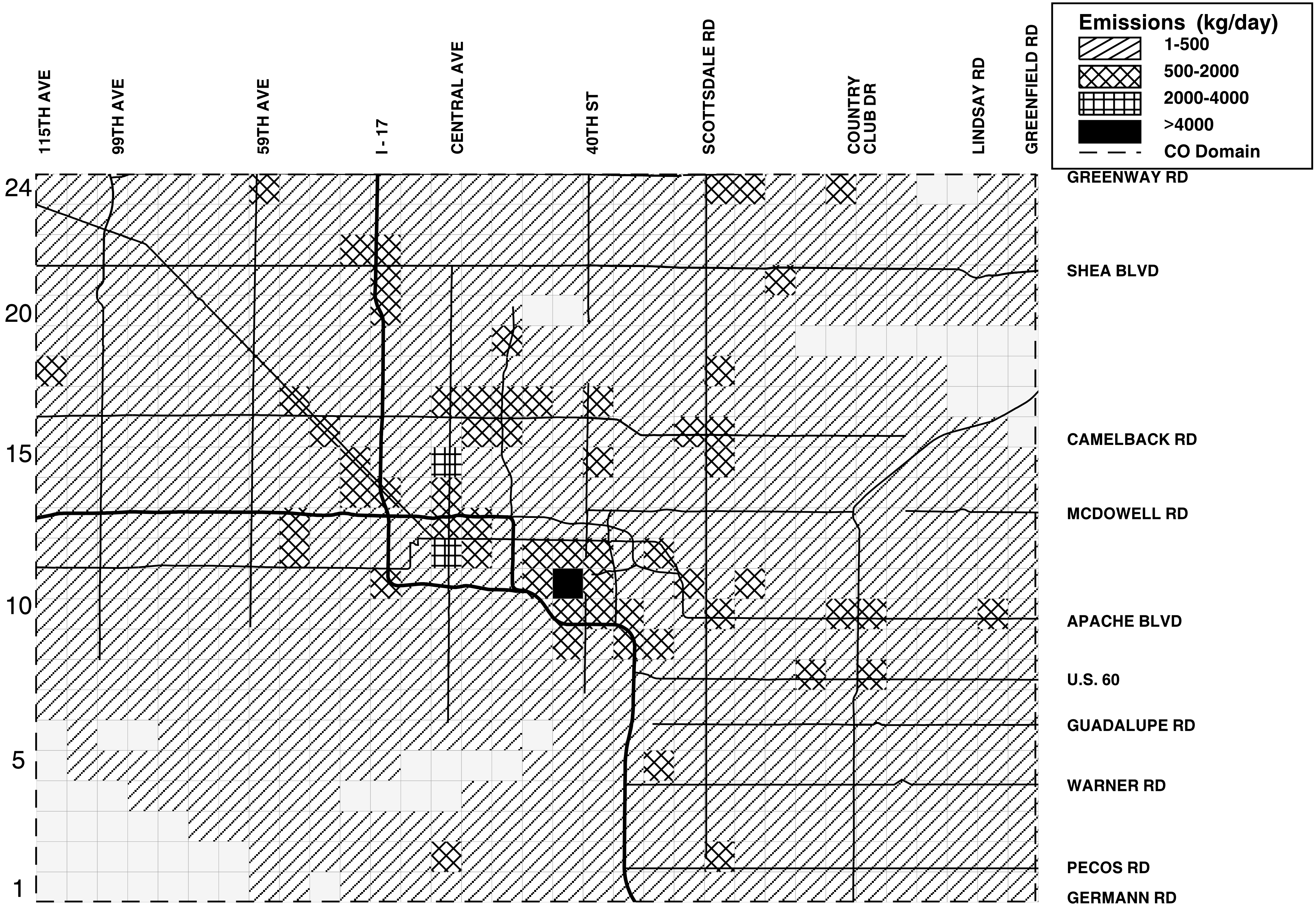


FIGURE III-7. CO background source emissions for Friday, December 16, 1994
Maximum Value = 4,736 kg/day at (18,11). Total = 178,573 kg/day

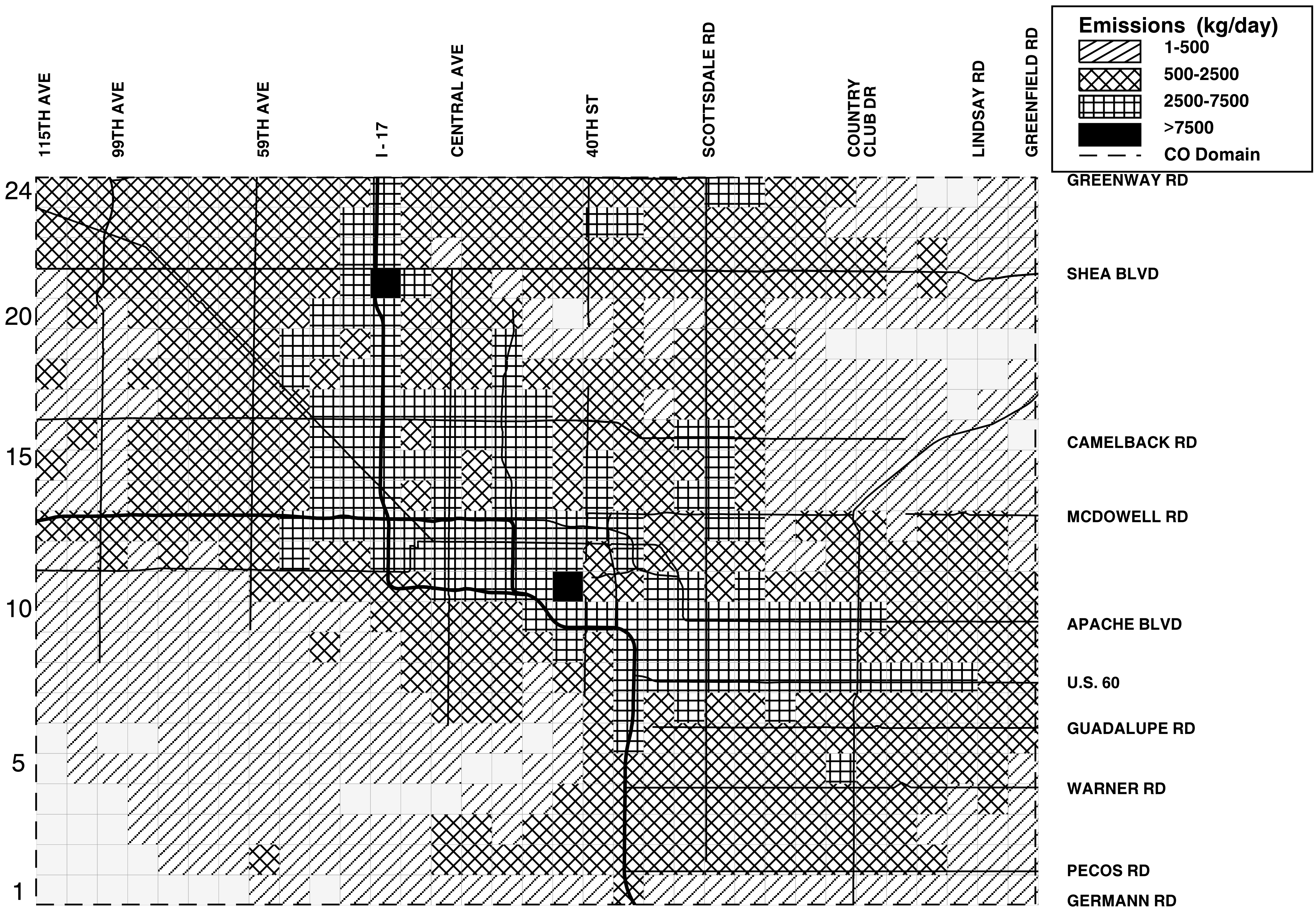


FIGURE III-8. CO total source emissions for Friday, December 16, 1994

Maximum Value = 9,965 kg/day at (18,11). Total = 1,048,167 kg/day

Table III-2. Emission totals for the December 1994 episode (metric tons/day).

Source	December 16	December 17
Point	2.5	2.5
Area	21.0	21.3
Nonroad Mobile	155.1	207.7
Onroad Mobile	869.6	538.1
Total	**1048.2**	**769.6**

Because UAM is an Eulerian grid-cell model in which pollutant concentrations are calculated as well-mixed grid cell volume averages, it cannot adequately simulate the breakdown of the afternoon mixed layer and the development of a surface-based inversion using a single interface such as DIFFBREAK to divide up to three stability regimes in the vertical direction. Further, estimates of the depth and strength of the nocturnal inversion cannot be adequately specified for this episode because of lack of data. The limitations noted above make it difficult to accurately specify these values even if some upper air data were available. Instead, for CO the UAM is configured with two vertical layers; a surface layer below the DIFFBREAK, and an upper layer above. The DIFFBREAK is specified to act not as the top of the surface-based inversion (which can be as deep as 100 meters or more), but rather as a very shallow vertical barrier that suppresses vertical pollutant transport to the upper region of the inversion, while being low enough so that a simulated surface layer concentration adequately represents an average of stably-stratified pollutants in the first few tens of meters above the ground.

In summary, the DIFFBREAK for CO modeling controls three regimes: (1) the collapse of the afternoon boundary layer in which the DIFFBREAK simulates the late-afternoon/early evening drop in the mixing height; (2) the gradual development of the nocturnal inversion in which the DIFFBREAK is further lowered to some minimum to act as the depth at which a layer-average concentration can be considered valid (usually 10-50 meters); and (3) the top of a growing morning mixing depth after sunrise.

The mixing heights to represent the DIFFBREAK were calculated using the MIXEMUP procedure [6]. The procedure, which is based on a simple one-dimensional model developed by Benkley and Schulman [3], consists of subjective and objective (computer-based) analysis of the data. Using this technique, hourly mixing heights are calculated for a given surface location using a nearby, representative upper-air sounding and the local hourly surface data. During the nighttime hours, when mixing is primarily mechanical, the mixing-height is a function of wind speed. A daytime convective mixing scheme is employed after sunrise. The height of the daytime mixed layer is estimated to be that point at which a dry-adiabatic air parcel anchored at the surface temperature intersects the 1200 GMT (0500 MST) sounding. The time of sunrise and sunset are specified as the hour at which the solar zenith angle, supplied by the SUNFUNC program [18] becomes less than and greater than 90 degrees, respectively.

The scheme for calculation of the convective mixing heights described above takes into account the atmospheric temperature changes resulting from surface heating. This process is called convective heating. Another mechanism for heating and cooling the atmosphere is advective heating. Advection refers to the horizontal transport of atmospheric properties, in this case temperature. Convective heating is the dominant mechanism for temperature change in the mixed layer and advective heating is the dominant mechanism above the mixed layer. The daytime temperature advection aloft is accounted for by modification of the hourly surface temperatures between the time of the morning (0500 MST) and the evening (1700 MST) soundings. The temperature advection aloft is defined as the difference in temperature between the 1700 EST and the 0500 EST soundings at 900 mb. The 900 mb level, which normally occurs at approximately 1000 meters above sea level, is chosen since it is near the top of the domain or above the mixed layer. The temperature difference is linearly interpolated in time and subtracted from the hourly surface temperature. The resulting modified surface temperature is termed the relative temperature. For example, if the temperature at 700 mb has increased between the 0500 EST and the 1700 EST soundings, the relative temperature will be lower than the actual surface temperature and will result in lower estimated mixing heights.

In previous CO studies, DIFFBREAK values have been varied in sensitivity tests in order to improve model performance. Simulated CO concentrations are quite sensitive to the specification of DIFFBREAK heights. Three PRISMS sites (Arcadia, Pera, and Alameda) are located near the center of the modeling domain. Using surface wind, temperature and pressure data from the three PRISMS sites and the Tucson sounding, the hourly mixing heights from averaging the MIXEMUP calculations range from 40 meters to 587 meters. Because the UAM region top was configured to be 210 meters (see next paragraph) and the minimum thickness for the upper layer is 20 meters, the maximum mixing height for this episode was set at 190 meters. It should be noted that due to the lack of sounding data within or close to the modeling domain, it is difficult to accurately specify the "actual" depth and strength of the mixing layer. The MIXEMUP calculations using Tucson soundings provide a physical justification of the hourly mixing height profile, but may not be representative of the mixing heights for the Maricopa County Nonattainment Area. Based on preliminary simulations using the DIFFBREAK heights from the MIXEMUP package, the minimum DIFFBREAK height for this study was set at 22 meters. Both qualitative and quantitative measure of model performance indicated that these DIFFBREAK heights result in a generally realistic simulation of the CO buildup throughout the modeling domain. The DIFFBREAK heights used in the current analysis are presented in Table III-3.

The REGIONTOP input file contains gridded heights of the top of the modeling domain. Following EPA guidelines [21] for UAM CO modeling, and being analogous to the previous CO modeling of December 1989 and 1992 episodes in Maricopa County [8], the region top is constant in time and space, with an initial value of 200 meters. The EPA guidance lists several conditions that might require the REGIONTOP value to be set higher than 200 meters. The conditions include: multiple day episodes, high CO events not associated with strong surface based inversions, or large contributions from elevated point sources. Since there will be more peaking power plants in the study area in 2006 and 2015 than those in 1994, the REGIONTOP was set to be 210 meters to accommodate the expected growth of the power plants in the study area. Considering that observed and modeled CO concentrations peak between 2000 MST and 0800 MST during the night of December 16-17, 1994, a time in which DIFFBREAK heights are less than 40 meters, a REGIONTOP height of 210 meters is appropriate.

Table III-3. The time varying (spatially invariant) input parameters for the current UAM study.

Starting Hour	DIFFBREAK (m)	TGRAD[1] Above (K/m)	Exposure Class[2]	Lapse Rate[3] (K/km)	Domain Mean Wind[4] u (m/s)	v (m/s)
11	131	.0075	1	18.6	-0.5	0.9
12	190	-.0038	1	19.4	0.3	1.3
13	190	-.0084	1	9.6	1.0	0.9
14	190	-.0084	1	3.8	1.5	0.8
15	190	-.0084	1	2.5	1.4	0.4
16	184	-.0084	-2	0.1	1.5	0.5
17	33	-.0042	-2	-5.2	1.0	0.1
18	22	-.0049	-2	-7.1	0.7	0.7
19	22	-.0052	-2	-1.7	0.2	0.6
20	22	-.0054	-2	5.5	-0.6	0.5
21	22	-.0052	-2	20.9	-0.5	0.6
22	22	-.0053	-2	31.3	-0.7	0.9
23	33	-.0052	-2	33.6	-0.8	0.6
0	22	.0000	-2	43.2	-0.7	0.7
1	22	-.0003	-2	48.8	-0.8	0.7
2	22	.0008	-2	43.1	-1.0	0.0
3	22	.0016	-2	45.8	-0.4	1.0
4	44	.0011	-2	51.4	-0.3	1.2
5	44	.0011	-2	53.8	-0.6	1.0
6	33	.0010	-2	52.1	-1.1	0.6
7	44	.0016	-2	58.4	-0.9	0.8
8	110	.0007	1	54.3	-1.2	0.2
9	110	-.0004	1	49.6	-1.4	0.5
10	121	-.0005	1	24.0	-1.0	1.0
11	121	.0000	1	18.5	-1.4	1.3
12	121	-.0086	1	-1.7	-0.9	1.6

[1] Temperature gradient above the mixing height.

[2] Near ground-level atmospheric stability due to surface heating or cooling.

[3] Domain averaged temperature lapse rate for each hour of the simulation day.

[4] u-component of the domain mean wind is the east-west vector of the wind; v-component of the domain mean wind is the north-south vector of the wind.

III-2-2. SURFACE TEMPERATURE

Temperature data are used to adjust chemical reaction rates in the UAM. Because the UAM is exercised in an inert mode for this study, no TEMPERATUR input file is used.

III-2-3. METEOROLOGICAL SCALARS

The METSCALARS input file contains hourly values of several meteorological scalars including atmospheric water vapor concentration, atmospheric pressure, NO_2 photolysis rate, exposure class, and vertical temperature gradients above and below the mixing height. The relevant spatially constant, temporally varying parameters for this application include exposure class and temperature gradients above the diffusion break. The SUNFUNC program estimates the zenith angle of the sun for each hour given the date and the location of the domain. The solar zenith angle output from SUNFUNC was also used to determine the exposure class, which is a measure of the near-surface meteorological stability. The exposure classes range from −2 (very stable) to 3 (very unstable) and are assigned according to the classification scheme in Table III-4. Clear sky conditions were assumed in estimating the exposure class for the modeled episode. Vertical temperature gradients above the diffusion break were estimated using the DIFFBREAK heights, the height of the region top, and the tethersonde sounding from Tucson. The time varying and spatially-invariant METSCALARS specified for the UAM are presented in Table III-3. The constant parameters are displayed in Table III-5. Note that the NO_2 photolysis rate constant, also noted as the radiation factor, impacts the photochemical reactions built into the carbon-bond chemical mechanism. Since the CO UAM simulation is exercised with inert mode, the radiation factor is set to zero.

III-2-4. WIND FIELDS

Methodology

In simulating wintertime CO conditions, stagnant winds, or weak flow generated by nocturnal drainage conditions, dominate the surface flow field. The drainage that occurs in the Maricopa County Nonattainment Area may be influenced by surrounding terrain features that are outside of the UAM domain. For this application, the wind field was developed using the terrain file from the MAG ozone study [7] and prepared for a larger domain extending 13 additional cells to the west, eight cells to the east, four cells to the south, and twelve cells to the north. This larger domain is depicted in Figure II-1, including isopleths of terrain heights. The inner rectangle in Figure II-1 denotes the location of the CO UAM domain. The locations of the available meteorological monitoring sites are also shown in Figure II-1. The observed input wind vectors were over plotted on the Diagnostic Wind Model (DWM) [4] and UAM wind fields as part of the diagnostic analyses procedures described in Section VI.

Table III-4. Exposure class (CE) classification based on cloud cover and solar zenith angle.

Solar Zenith Angle (degrees)	Cloud Cover (percent)	CE
> 85	≤ 50	−2
> 85	> 50	−1
≤ 30	≤ 50	3
≤ 30	> 50	2
$30 < \Theta \leq 55$	≤ 50	2
$30 < \Theta \leq 55$	> 50	1
$55 < \Theta \leq 85$	≤ 50	1
$55 < \Theta \leq 85$	50	0

Table III-5. Time and Space invariant UAM input parameters.

Parameter	Value
Lateral Boundary Concentration (ppm)	0.5
Top Boundary Concentration (ppm)	0.5
Region Top (m)	210
Surface Roughness Factor	0.5
Deposition Factor	1.0
Water Vapor (ppm)	12687
Atmospheric Pressure (atm)	0.96
Radiation Factor	0.0

The wind file contains hourly, gridded, horizontal wind fields for each of the UAM layers. For this application the wind fields were generated using DWM. This model incorporates available observations and provides some information on terrain-induced airflows in regions where observations are absent. The application of the DWM is a two-step process. In the first step, a domain mean wind and stability were estimated for each hour of the day. This field was adjusted by the following effects: up-slope and downslope flows (drainage), kinematic effects (lifting and accelerations) caused by terrain features, and accelerations caused by blocking effects of terrain. The step one surface wind field was then adjusted in step two using surface observations in an objective analysis.

The step one winds aloft were adjusted using the observed wind information at Tucson and Winslow which are located to the southeast and northeast of the UAM domain, respectively. The resulting step two flow field was then processed through a divergence minimization algorithm to eliminate any spurious divergence that may have been generated, either in step one or two. The winds for the UAM grid were then extracted from the resulting DWM wind fields on the large domain.

Surface wind data were available for thirty sites within and around the domain. These sites are plotted in Figure III-9 and listed in Table III-6. Upper-air wind measurements were limited for the modeled episode. Upper-air wind soundings were from Tucson International Airport and Winslow Municipal Airport.

Generation of the wind fields involved: (1) preprocessing of the wind data for input to the model, (2) specification of model input parameters, (3) execution of the DWM, and (4) postprocessing of the DWM fields for input to the UAM. Winds were analyzed within each of nine layers: 0-10,10-25, 25-50, 50-100, 100-150, 150-200, 200-250, 250-300, and 300-400 meters above ground level (m agl). In the preprocessing step, the surface and upper-air data were temporally interpolated to provide hourly inputs for the DWM.

Maximum radii of influence for the interpolation of the data were based on the spatial distribution of observations, and were assigned values of 230 kilometers for the surface-layer and 300 kilometers aloft. The distance from the observations at which the terrain effects begin to dominate the surface-layer wind field was specified to be five kilometers which is governed by the dominant scale of the terrain features.

The DWM also requires domain-mean wind and domain-scale stability information. For December 16 and 17, the hourly domain-mean wind was obtained by averaging the thirty surface wind stations. The hourly domain-mean lapse rate was assumed to be represented by the temperatures at the Bank One Tower which is approximately 520 meters high, and Sky Harbor International Airport which is 349 meters high. The hourly values used are provided in Table III-3.

Table III-6. Surface wind data were available for thirty sites within and around the domain.

Abbr.	Name	Site Operator	Location	UTM Zone 12 (m) Easting	Northing
ALAM	Alameda	PRISM	Southern Ave & Dorsey Ln	414518	3695417
ARCA	Arcadia	PRISM	Bamelback Rd & 40th St.	406863	3708085
COLL	Collier	PRISM	107th Ave & I-10	380172	3703143
CORB	Corbell	PRISM	McQueen Rd. & Guadalupe Rd	422957	3690973
CPHX	Central Phoenix	MCESD	1845 East Roosevelt	403224	3702365
FACN	Falcon	PRISM	McDowell Rd & Greenfield Rd	431961	3703348
FALC	Falcon Field	MCESD	4530 East Mckellips	431884	3701512
FLAG	Flagstaff/Pulliam	NWS	6200 S Pulliam Dr.	438853	3888399
FONT	Fountain	PRISM	Coyote Dr & El Lago Blvd.	434202	3717838
GLEN	Glendale	MCESD	6000 West Olive	389475	3714845
KAY	Kay	PRISM	43rd Ave and Lower Buckeye Rd.	392837	3694481
MESA	Mesa	MCESD	370 South Brooks	419633	3696938
PALV	Palo Verde	ADEQ	36248 W. Elliot Rd	329369	3689549
PERA	Pera	PRISM	McDowell Rd & Cross Cut Canal	412777	3702948
PINN	Pinnacle Peak	MCESD	25000 Windy Walk Way	421092	3730363
PRES	Prescott/Municipa	NWS	6546 Crystal Lane	368674	3834968
PRIN	Pringle	PRISM	23rd Ave & Dunlap Rd	397208	3714898
RITT	Rittenhouse	PRISM	Ellsworth Rd & Queen Creek Rd	440647	3680162
SHEE	Sheely	PRISM	71st Ave & Osborn Rd	386991	3705648
SKYH	Sky Harbor Intl Airport	NWS	Sky Harbor Intl Airport	407040	3699582
SPHX	South Phoenix	MCESD	Central Ave & Broadway	400209	3696337
SPUR	Spurlock	PRISM	US 60 & Kings Ranch Rd.	457642	3690913
SSCT	South Scottsdale	MCESD	2857 North Miller Road	414851	3704625
STAP	Stapley	PRISM	Stapley Dr & Consolidated Canal	425245	3699424
STEW	Stewart Mountain	PRISM	Near Stewart Mountain Dam	450493	3713121
SUNL	Sun Lakes	PRISM	Dobson Rd & Riggs Rd	418543	3676318
SUPR	Superstition	PRISM	Cactus Rd & Junction St.	450104	3697632
TUC	Tucson/Int'l Airport	NWS	7005 S Plumer Ave.	506320	3554991
WIND	West Indian School	MCESD	33rd Ave. & W. Indian Sch. Rd.	395007	3706551
WPHX	West Phoenix	MCESD	3847 West Earll Road	393893	3705301

The DWM winds were converted to the UAM mixing-height-based layers using a stability-dependent layer matching scheme which, for unstable conditions, incorporates information from the surface-layer DWM fields into certain upper-layer fields. Following the stability adjustment, the DWM wind fields were interpolated to the UAM layers. An initial vertical velocity was calculated, and the vertical velocity profile was adjusted so that the vertical velocities at the top of the modeling region were negligible. Finally, the three-dimensional divergence was minimized.

The UAM wind fields for the December 16-17 episode are presented in the remainder of this section. The second layer winds represent the winds above the mixing height which vary in time and space.

<u>Wind Fields for December 16-17, 1994</u>

Although this episode is primarily characterized by southerly to southwesterly flow, wind speeds and directions vary throughout the period. Appendix IV-i depict the surface-layer winds for December 16 and 17. At 1200 MST on December 16, the surface winds were generally from the north and east over the central portions of the modeling domain with some flow from the north and west in the northeast and northwest portions of the domain, respectively. Downslope-directed flow is evident in the vicinity of the terrain features. From 1400 to 1900 MST, the surface-layer wind fields are characterized by easterly and southerly flow. Some northerly winds developed at left portion of the domain at 2000 MST. The surface-layer winds veered either southerly or southwesterly for the remainder of the day.

Surface-layer winds on December 17 are light and variable in the western and south portion of the domain. At 0100 MST, a convergence zone near the central portion of the modeling domain in the surface-layer wind field is evident. The southerly flow component is evident in the surface-layer wind which is characterized by moderate southwesterly winds. By 1200 MST, the surface flow is still light and mostly from the northeast, but the wind speed in the northeast portion of the domain increases.

III-3. Air Quality Inputs

Air quality inputs required by the UAM include initial concentrations of each of the simulated chemical species (AIRQUALITY), hourly concentrations of each chemical species along the boundaries of the modeling domain (BOUNDARY), and hourly concentrations of each species for the area above the modeling domain (TOPCONC). These inputs were developed using available observed air quality data or EPA recommended values.

<u>III-3-1. INITIAL CONDITIONS</u>

The AIRQUALITY file provides concentrations of the chemical species used in the UAM Carbon-Bond IV chemical mechanism at the initial hour of the simulation. In this application, only CO concentration is needed. Initial concentrations of carbon monoxide (CO) were based on available measurements. Data were interpolated to provide spatially varying, gridded initial concentration. At the beginning of the simulation, CO concentrations throughout the domain should be low, and relatively uniform throughout the domain. Following the methodology used in the 1993 CO SIP for Maricopa County [8], the model was initialized at 1200 MST on 16 December 1994 for the current study. See Table III-7 for the information of the available air quality monitoring data. Figure III-9 shows the locations of the air quality monitoring sites in the modeling domain for which data were available for the modeled episode. The UAM preprocessor AIRQUL was used to horizontally interpolate the air quality data shown in Table III-7 to each grid cell in UAM layer one using inverse distance weighting; a constant vertical concentration profile was specified for each grid column assuming that concentrations were well mixed within 210 meters above the surface during the 1200 - 1300 MST period.

The radius of influence for the interpolated species was based on data density and ranged from 20 to 100 kilometers. Initial conditions for the future-year simulations were the same as those used for 1994. Total modeled CO emissions decrease by approximately fourteen percent from 1994 to 2015. In addition, the sensitivity analysis as shown in Section IV-1-1 showed that changes of the UAM results due to decrease in the initial conditions are negligible. Therefore, the use of the 1994 initial conditions in the 2006 and 2015 analyses is considered an appropriate and conservative approach.

III-3-2. LATERAL BOUNDARY CONDITIONS

Concentrations of the chemical species along the lateral boundaries of the modeling domain are specified in the BOUNDARY input file. Based on EPA recommended background concentrations for carbon monoxide, a constant value of 0.5 ppm was assigned to all lateral boundaries for the simulation period. This value is recommended for urban areas. In several CO modeling exercises, sensitivity simulations conducted with zero boundary conditions showed little effect of the boundary conditions on simulated peak CO concentrations (see Section IV-2). The domain boundary is therefore believed to be adequately defined so that the assumptions of boundary values would have minimal effect inward to where high CO concentrations were predicted.

III-3-3. UPPER BOUNDARY CONDITIONS

The TOPCONC file contains pollutant concentrations along the top of the modeling region.

The CO concentration above the modeling domain was set to a time- and space-invariant value of 0.5 ppm. It is consistent with the lowest observed concentrations at noon on December 16 (see Table III-7) — a time when high mixing is expected to lead to the lowest uniform concentrations throughout the domain. Furthermore, the wind field during the night

Table III-7. Observed CO concentrations used to develop initial concentration fields for UAM (December 16, 1994 @ 1200 MST).

Site Name*	Site ID	CO (ppm)
Central Phoenix	CPHX	1.30
South Phoenix	SPHX	1.50
Glendale	GLEN	1.70
West Phoenix	WPHX	1.60
North Phoenix	NPHX	2.00
South Scottsdale	SSCT	0.90
Mesa	MESA	0.50
W. Indian School Rd.	WIND	2.40
Phoenix Post Office	PHPO	1.61
Phoenix Grand Avenue	PGRA	1.92
Phoenix Supersite	SUPE	1.92
Gilbert	GILB	0.6
Ocotillo	OCOT	3.1

*Maryvale site did not have data until 1300 on December 16, 1994.

of December 16-17 was characterized by very weak motion and large areas of stagnation. Very little vertical velocity is diagnosed from such wind patterns; therefore, the vertical flux of CO into the domain from above is expected to be negligibly small. This would lead to TOPCONC having an insignificant impact on upper layer CO concentrations, and minimal impact on surface layer concentrations through the night, since mixing across the DIFFBREAK is extremely limited.

III-4. Other Inputs

III-4-1. SURFACE ROUGHNESS AND DEPOSITION

The UAM TERRAIN file contains the surface roughness and vegetation factors used to calculate the vertical diffusivity and surface deposition in UAM. Because no deposition was allowed in these applications, the values specified in this file have no effect on simulated concentrations. In order for UAM to be executed successfully, the EPA recommended surface roughness factor of 0.5 and a constant deposition factor of 0.3 were specified for the entire modeling domain.

Chemistry Parameters

For simulating CO concentrations, the species CO is denoted as being unreactive. Therefore, CO is the only species designated in the CHEMPARAM file.

Simulation Control Parameters

The SIMCONTROL file contains the simulation control information, including the period of simulation, model options, and information on the integration time steps. For this application, the simulation period extended from 1200 MST on the first simulation day to 2400 MST on the second day. This period was selected to include a start-up simulation day to ensure that the peak concentration for the primary episode day is simulated.

SECTION IV. QUALITY ASSURANCE AND DIAGNOSTIC ANALYSES

Some diagnostic and sensitivity analyses were performed to further examine the model inputs, identify and correct errors in the input files, examine the effects of uncertainty in the inputs on the simulation results, and investigate the sensitivity of the model to various input parameters. The objectives, procedures, and results of the diagnostic and sensitivity simulations are described in this section. It should be noted that similar behavior of CO modeling responses to diagnostic and sensitivity analysis should be observed for different emission inventories. Similar analysis for the new emissions inventories were therefore deemed unnecessary. The meteorological data, air quality data, and location of all the monitoring stations were plotted and examined to ensure accurate representation of the observed data in the UAM-ready files, temporal and spatial consistency, and reasonableness. The plots presented in Appendix IV are examples of this type of graphical analysis.

Diagnostic analysis was used to examine the effects of uncertainty (especially with regard to the assumptions invoked during the input preparation process) and to identify possible deficiencies in the model inputs. Sensitivity analysis was used to investigate the sensitivity of the model to the various model inputs and to ensure that the response of the model to changes in the inputs is physically realistic. Following the preparation of inputs and initial application of the UAM, a series of diagnostic and sensitivity simulations were performed. The results of these simulations were examined/assessed using a variety of graphical and statistical analysis products including (1) time-series plots of the observed and simulated pollutant concentrations, (2) contour plots showing isopleths of simulated pollutant concentrations and observed values for the surface monitors, and (3) model performance statistics.

The diagnostic and sensitivity simulations that were performed for this episode included meteorology- and air-quality-related. Improvements to the inputs were made throughout the analysis process. These included corrections to the input files when errors were uncovered, as well as adoption of alternate assumptions that, when applied, resulted in more physically realistic inputs and, in most cases, improved simulation results. A brief description of the diagnostic/sensitivity analysis and input modification process is provided herein.

IV-1. Quality Assurance Tests of Input Components

The purpose of this testing is to establish that apparently good model results are the result of valid model inputs and assumptions, and not the result of compensating errors in input data. Prior to conducting a base case simulation, individual air quality, meteorological, and emissions fields will be reviewed for consistency and obvious omission errors. Both spatial and temporal characteristics of the data will be evaluated. Examples of component testing include air quality-, emissions-, and meteorology-related data files.

IV-1-1. AIR QUALITY

The initial condition of the CO concentration field was generated using the observed CO taken at the stations available in the modeling domain. The observed data used for preparing the initial conditions range from 0.5 to 3.1 ppm and are shown in Table III-7. The UAM preprocessor AIRQUAL was used to horizontally interpolate the air quality data shown in Table III-7 to each grid cell in UAM layer one. A constant vertical concentration profile was specified for each grid column.

A constant value of 0.5 ppm was assigned to all lateral and top boundaries for the simulation period based on EPA recommended background concentrations for carbon monoxide, in the absence of sufficient monitored data.

The UAM-ready AIRQUALITY, BOUNDARY, and TOPCONC files were checked to make sure that correct order of magnitude, compared with available monitored data or EPA recommended values, were used in the UAM runs.

IV-1-2. EMISSIONS

The emissions inventories were tabulated, plotted, and examined as presented in the associated sections in the present Technical Support Document (TSD). The major assumptions, accounting of emissions totals throughout the development process, and verification of spatial distribution of emissions against known source locations and emission strengths have been documented in the TSD as part of the quality assurance process. Any missing or unreasonable data values identified during the quality assurance process were verified and corrected as appropriate.

IV-1-3. METEOROLOGY

In processing the DWM wind fields for input into the UAM, it is customary to adjust the vertical velocity profile so that the vertical velocity at the top of the DWM modeling domain is approximately zero. This prevents exchange of mass through the top of the modeling domain (i.e., loss of pollutants when the vertical velocity is upward and entrainment of air with unknown chemical composition when the vertical velocity is downward). Adjustment of the vertical velocity, however, requires restoration of mass consistency. This is achieved through the iterative adjustment of the horizontal wind components.

The resultant wind fields from the O'Brien adjustment procedure may greatly deviate the simulated winds from the observations. Furthermore, the DWM winds need to be processed through UAMWND for conversion of the temporally-invariant vertical layers to those in the UAM which vary with the top of the domain and mixing height. This process includes a built-in O'Brien procedure. Note that the wind fields used by UAM are those converted by UAMWND rather than those generated directly from DWM. Given this discussion, together with the critically few upper-air soundings available in the present study (zero in the domain, two from outside of the domain), it was concluded that the O'Brien option should be turned off when using DWM. By comparing the simulated DWM winds with the observed winds, some deviation of the surface wind field was observed by turning on the O'Brien procedure. Again, the predictability of the model response helps to eliminate the possibility of compensatory errors in the model inputs.

Plots of the wind fields were generated at two stages during the analysis. First, the DWM fields for several times and vertical levels were plotted. Vectors representing the wind observations were plotted over the wind fields to facilitate comparison between the calculated and observed winds. Following application of the postprocessing procedure, the UAM-ready wind fields were also plotted and examined to ensure that the vertical averaging from the DWM to the UAM layers was properly implemented and that the resulting fields were physically reasonable. The plotted wind vectors can be found in Appendix IV-i.

Simulations were performed to examine the effects of the assumptions invoked during the preparation of the meteorological input fields on the UAM simulation results. These simulations revealed some sensitivity to the specification of the mixing height field. The initial mixing fields were prepared using the surface data from Alameda site and Tucson soundings for MIXEMUP calculation. Please note that the DIFFBREAK is specified to behave not as the top of the surface-based inversion, but rather as a very shallow vertical barrier that suppresses vertical pollutant transport to the upper region of the inversion. Mixing heights from MIXEMUP, however, provide a general insight of the variation of the "vertical barrier" during the episode. A preliminary simulation using the DIFFBREAK heights from the MIXEMUP package resulted in predicted CO concentrations that are greatly lower than observed values. Because the chemistry of CO UAM is treated as inert, the CO concentrations are generally inversely proportional to the height of DIFFBREAK if the other parameters are left unchanged. By examining the CO time-series plots comparing predictions and observations, and the performance statistics, the DIFFBREAK heights were adjusted to those presented in Table III-3.

The hourly mixing heights were plotted, as shown in Figure IV-1, to ensure reasonable diurnal and nocturnal mixing patterns.

IV-2. Diagnostic Tests of Base Case Simulation

After conducting the above quality assurance tests, UAM run were conducted for the base case episode. Emphasis were placed on correctly depicting the areawide distribution and timing of observed CO concentrations. Spatial and time series plots were used to assess model behavior.

To aid the interpretation of simulation results, predicted and observed CO concentration maps were constructed for each base case simulation. Concentration maps present

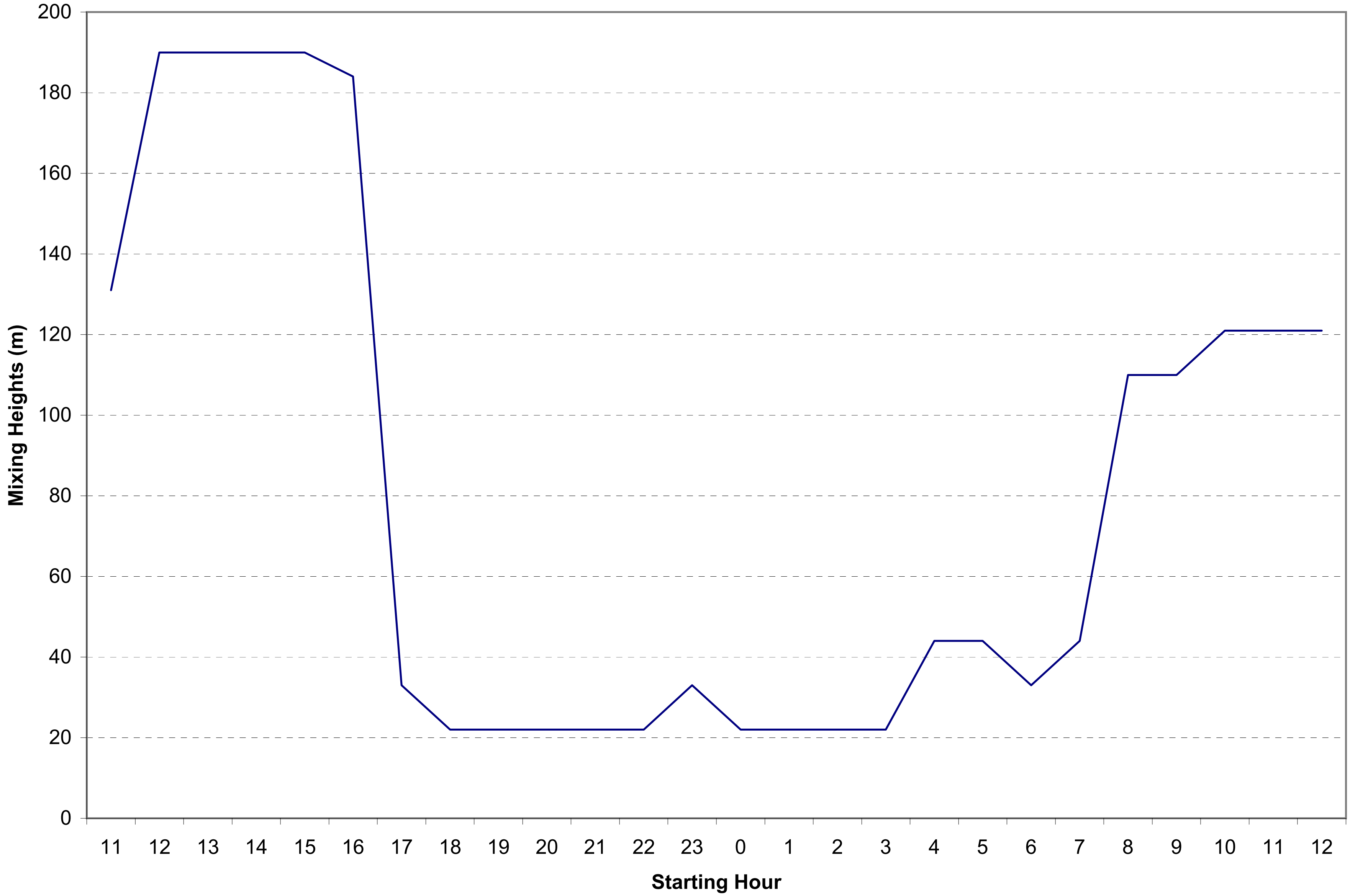


Figure IV-1. Hourly mixing heights used in the current study.

spatial distribution of CO concentrations. Maps of the 8-hour CO at one hour intervals were constructed over periods of most interest as shown in Appendices IV-ii and IV-iii. While a typical period might be defined as early morning to late afternoon for the day of highest CO concentration, it is useful to look at most time intervals under recirculation, stagnation, and transport conditions. Maps which depict the highest predicted daily maximum CO value for each grid cell were also constructed (an example is shown in Figure VI-1). Various mapping techniques were based on those described in Tesche et. al. [27]. The predicted concentrations used in the time-series plots were defined using the same method for deriving predicted concentrations for the model performance evaluation. This method consists of a four-cell weighted average using bilinear interpolation of the predictions from the nearest four grid cells to the monitor location and is also based on Tesche et. al. [27].

In addition to the various graphical display methods, the base case was tested with additional investigative simulations to complement and extend the various numerical and graphical measures of model performance by providing a straightforward measure of model robustness. The simulations included but were not limited to those recommended in the guidance document [21] for areawide CO modeling.

Zero Boundary Conditions

Inflow concentrations at the lateral boundaries and top of the modeling domain were reduced to zero. Sensitivity of the concentrations in the inner core and downwind portions of the modeling domain provided a measure of the influence of the boundary conditions. This simulation provided assurance that the upwind extent of the domain is adequate. The simulation with zero boundary conditions slightly decreased the simulated peak CO by about 1.3 percent.

Double Boundary Conditions

A simulation doubling the boundary conditions (set to 1 ppm) was performed to examine the sensitivity of the simulated CO concentration to the boundary concentrations. As expected, increasing the CO concentrations by 0.5 ppm along the boundaries of the modeling domain slightly increased the simulated peak concentrations by about 1 percent.

Zero Initial Conditions

Initial concentrations for all grid cells were reduced to zero. Sensitivity of concentrations within the modeling domain provided a measure of the influence of the initial conditions. Changes of less than a few percent indicate that the initial conditions are not dominating concentration estimates within the domain. The simulation with zero initial conditions decreased the simulated peak CO by about 4.6 percent.

Variations Diffusion Break Heights

Sensitivity of the concentrations within the modeling domain provided a measure of the influence of diffusion break heights. Diffusion break heights were doubled for one simulation and halved for another. The simulation doubling the base case diffusion break heights decreased the simulated peak CO by about 39.73 percent. A 50 percent reduction in the DIFFBREAK heights increased the peak simulated CO concentration by approximately 71.18 percent.

The tests for boundary and initial conditions confirm that the modeling domain and initial hour are adequately defined. The expected responses to the variations of the diffusion break heights helped eliminate the possibility of compensatory errors in the input fields. These simulations provided assurance that the lateral and top boundary conditions, initial conditions, and diffusion break heights are adequate.

IV-3. Test Results/Input Modifications

Following the diagnostic modeling analyses, the simulation results were carefully examined for possible modification or refinement of the input components. The performance of UAM for each base case simulation was evaluated to determine whether or not it was acceptable, with or without input modifications. The model performance criteria listed in the EPA guidance [21], also presented in Section VI of this document, were used in the evaluation.

SECTION V. MICROSCALE ANALYSIS

Microscale modeling using the intersection model CAL3QHC [25] to predict localized "hotspot" impacts is described in this section. Microscale carbon monoxide (CO) concentrations have been calculated for the Thomas Road microscale site and Indian School Road microscale site. It is important to note that this analysis does not include the ambient Urban Airshed Model (UAM) background concentrations, which are added to the CAL3QHC microscale component to produce a total CO concentration.

CAL3QHC is a computer-based modeling methodology developed to predict carbon monoxide (CO) or other inert pollution concentrations from motor vehicles traveling near a roadway intersection. Based on the assumption that vehicles at an intersection are either in motion or in an idling state, the program is designed to predict air pollution impacts by combining the emissions from both idling and moving vehicles with meteorological data. The model contains the CALINE-3 line source dispersion model and algorithms for estimating vehicular queue lengths at signalized intersections.

CAL3QHC is designed to produce pollutant concentrations in one hour segments, using input data specific to the hour being modeled. The June 1992 EPA guidance document [21] recommends that UAM performance be validated against eight hour predictions rather than one-hour predictions. CAL3QHC hour specific outputs were combined into eight hour average concentrations to facilitate their addition to eight-hour UAM background concentrations.

Two intersections in Phoenix were examined for this study: (1) 27th-Grand-Thomas (PHGA) and (2) 35th-Grand-Indian School Road (WISR), for both base (1994) and future (2006 and 2015) years. These two intersections are consistent with those previously examined for the CO attainment demonstration as described in Chapter III of the MAG Serious Area CO Plan [11] (referred to as the *Revised CO TSD* in the exhibit). The transportation network modeling using the EMME/2 model indicates that the two intersections are expected to be classified with the level of service F in 2015. The level of service is a ranking of the average delay per vehicle at the intersection, and is generally ranked from A to F. The ranking A represents the shortest delay and F represents the longest delay. The ranking F indicates that this intersection has an average delay of over 60 seconds per vehicle. Also, EMME/2 indicates that these intersections are expected to have among the highest intersection volumes in the modeling domain in 2015. Besides, both intersections have monitors which can be used for modeling performance evaluation purposes. Finally, the monitor at the WISR hot spot recorded the highest CO concentration of 10.5 ppm in the 1994 episode. Given the reasons above, the same two intersections are adequate to be modeled as hot spots for the maintenance plan.

Many of the inputs to the maintenance plan modeling have been carried forward from the Revised CO TSD [11] modeling with several exceptions. The hourly emission factors and hourly traffic volumes have been updated to reflect the maintenance plan modeling assumptions for 2006 and 2015. Also, the intersection configuration at PHGA is expected to change before 2006. Specifically, a “fly-over” is to be constructed for the Grand Avenue portion of the intersection during 2003. The expected change in the intersection is reflected in the configuration modeled with CAL3QHC, as described in the following section. Additionally, minor updates to the roadway link locations for the WISR intersection have been implemented. Also, default arrival type data has been implemented, resulting from the change in the PHGA intersection configuration.

V-1. Intersection Geometry

The following parameters are required to describe the roadway geometry:

- Start and end point link coordinates,
- Source height,
- Mixing width,
- Link type, and
- Number of lanes (queue link only).

Each of these parameters is required for each free flow and queue link. Mixing width is the roadway width for queue links and equals the roadway width plus three meters on either side of a free flow link. Link types are “at grade” for links that are level with the surrounding area, “bridge” for links that are elevated, or “depressed” for links that are lowered.

The MAG Regional Council approved the Grand Avenue Major Investment Study Final Report, September 1999, which included the construction of a fly-over for Grand Avenue at the PHGA intersection by 2015. For the PHGA intersection analysis reflecting future years (2006 and 2015), physical information regarding roadway geometry and intersection configuration, including the width and elevation of the roadway and the number of idle and free flow lanes in each direction were based on ADOT “recommended concept, not for construction” technical drawings of the proposed intersection reconfiguration, dated September 1999. These intersection plans were examined to determine the physical layout as described by roadway link coordinates, roadway widths, and roadway elevations. For the base year analysis of 1994 the PHGA intersection does not reflect the fly-over, but reflects a configuration consistent with the Revised CO TSD [11].

For the WISR intersection, roadway geometry was kept consistent with the Revised CO TSD modeling with minor updates to three link end coordinate locations. These geometric coordinates were then computer mapped to display the configuration of the intersection and to facilitate receptor location (see Figures V-1, V-2, and V-3).

Thomas Road and Grand Intersection

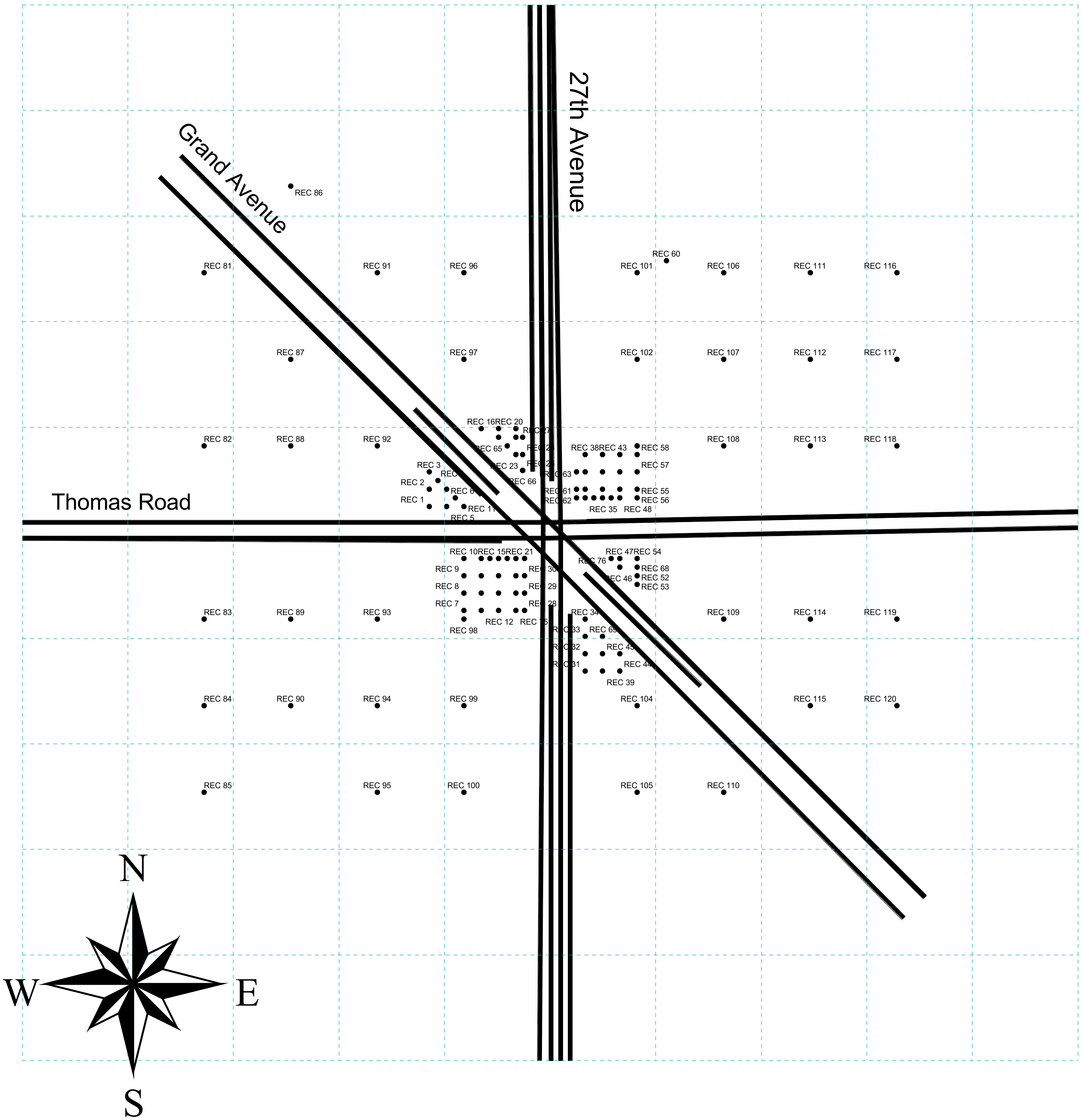


Figure V-1. Configuration of the Thomas / Grand / 27th Intersection indicating the location of the PHGA hotspot receptors in 1994

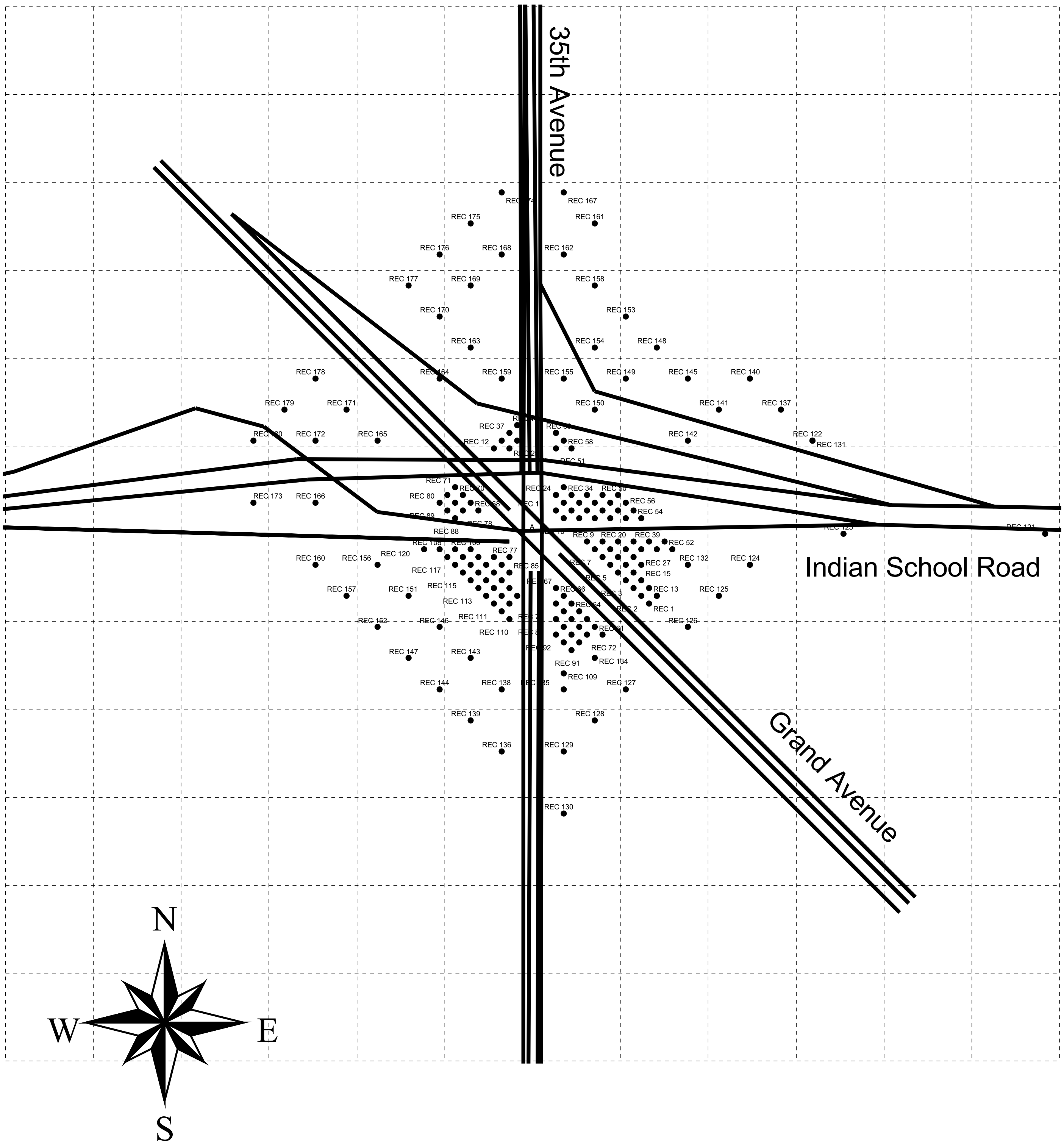


Figure V-2. Configuration of the ISR / Grand / 35th Intersection indicating the location of the WISR hotspot receptors

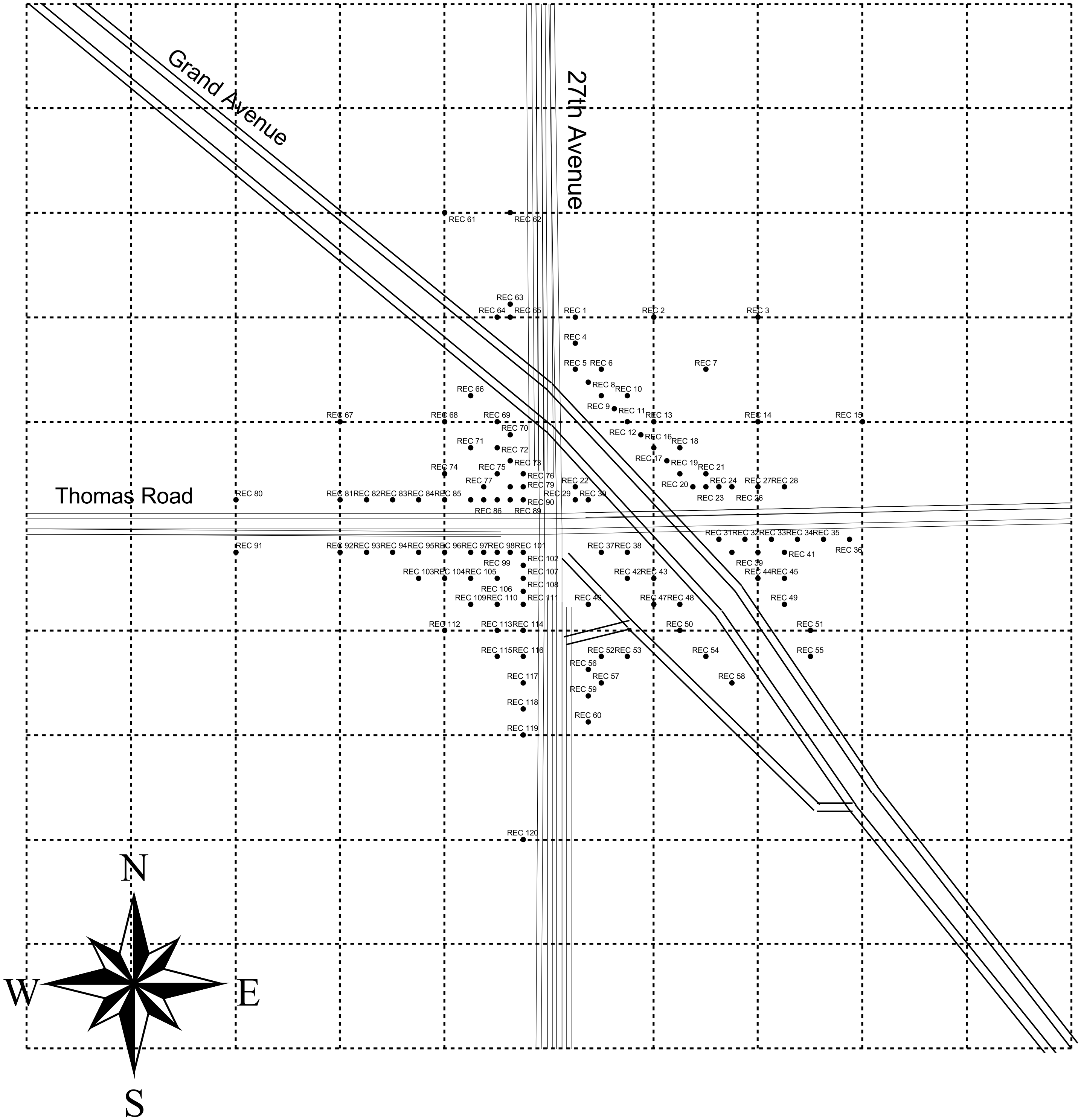


Figure V-3. Configuration of the Thomas / Grand / 27th Intersection indicating the location of the PHGA hotspot receptors in 2006 and 2015

V-2. Receptor Locations

The location of receptors around each intersection is critical to determining the maximum concentration. For both intersections, a dense array of receptors (approximately 10 m apart) surrounding the intersection was modeled in order to locate the maximum hotspot eight-hour average concentration. The intersection geometry data for both intersections were input into a mapping program to determine the accuracy of the data and to place the appropriate receptor sites. No receptors were placed within a roadway or the roadway mixing width. Since CAL3QHC can accept up to 60 receptors, 180 receptor locations (three runs) were used to locate the maximum concentrations at the WISR intersection and 120 receptors (two runs) were used at the PHGA intersection, consistent with the Revised CO TSD. Receptor heights were set to two meters.

V-3. Traffic and Signal Data

CAL3QHC requires inputs describing the queue of vehicles at the intersection as well as the free flowing traffic. Hourly traffic and signal inputs required include:

- Approach volume,
- Total signal cycle length,
- Red total signal cycle length, and
- Clearance lost time.

The traffic data input to CAL3QHC represent average hourly conditions during the modeling period and were derived from a 2015 EMME/2 traffic assignment, which combined 2015 socioeconomic projections with 2015 highway and transit network data. A comparison of the daily modeled traffic through the intersections in 2006 versus 2015 was conducted. Since the total volumes in both years are at capacity (level of service F) at these microscale intersections, the 2015 traffic volumes were also used in the 2006 analysis as a conservative approach.

Traffic data were estimated for both the approach and departure of each free flowing and queue link of each intersection. The free flow speeds by roadway were kept constant with the Revised CO TSD. Note that although the free flow speeds are not increased with the construction of the fly-over, the queue lengths and idle times are expected to be reduced. In addition, day of the week and monthly adjustments were applied to produce hourly volumes for a Friday and Saturday in December. Hourly volumes by link input to CAL3QHC may be found in Tables V-1(a) and V-1(b).

For each queue link at the WISR intersection, signal cycle length (seconds), red time length (seconds) and clearance interval lost time (seconds) were consistent with data used in the Revised CO TSD [11]. For queue links at the PHGA intersection, red time length

Table V-1(a)
Hourly link-specific traffic volumes at Indian School Road microscale intersection (1994)

	12 (noon	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10	11
ISR13	2114	1991	1907	1948	2145	2424	1919	1417	975	963	770	614	423	325	181	118	109	220	403	649	893	1121	1320	1486
ISR12	1816	1709	1637	1630	1795	2028	1647	1216	837	827	661	527	362	278	155	101	94	188	345	555	764	960	1130	1272
ISR09	1568	1476	1414	1321	1453	1643	1423	1050	723	714	570	455	308	237	132	86	80	160	294	473	651	817	962	1083
ISR07	1568	1476	1414	1321	1453	1643	1423	1050	723	714	570	455	308	237	132	86	80	160	294	473	651	817	962	1083
ISR05	1568	1476	1414	1321	1453	1643	1423	1050	723	714	570	455	308	237	132	86	80	160	294	473	651	817	962	1083
ISR03	1568	1476	1414	1321	1453	1643	1423	1050	723	714	570	455	308	237	132	86	80	160	294	473	651	817	962	1083
ISR04	1274	1278	1264	1466	1320	1163	1077	747	639	540	373	293	299	230	128	83	77	156	285	459	632	794	934	1052
ISR06	1274	1278	1264	1466	1320	1163	1077	747	639	540	373	293	299	230	128	83	77	156	285	459	632	794	934	1052
ISR08	1274	1278	1264	1466	1320	1163	1077	747	639	540	373	293	299	230	128	83	77	156	285	459	632	794	934	1052
ISR10	1274	1278	1264	1466	1320	1163	1077	747	639	540	373	293	299	230	128	83	77	156	285	459	632	794	934	1052
ISR11	1525	1560	1558	1769	1582	1419	1351	1027	897	704	489	372	366	281	156	102	95	190	349	561	773	970	1142	1286
OFF07	214	241	244	270	261	246	217	176	151	129	96	73	52	40	22	15	14	27	50	81	111	139	164	185
OFF04	214	241	244	270	261	246	217	176	151	129	96	73	52	40	22	15	14	27	50	81	111	139	164	185
OFF03	214	241	244	270	261	246	217	176	151	129	96	73	52	40	22	15	14	27	50	81	111	139	164	185
OFF02	214	241	244	270	261	246	217	176	151	129	96	73	52	40	22	15	14	27	50	81	111	139	164	185
OFF01	214	241	244	270	261	246	217	176	151	129	96	73	52	40	22	15	14	27	50	81	111	139	164	185
OFF08	253	282	295	303	264	256	273	280	258	163	117	80	67	51	28	19	17	35	64	102	141	177	208	234
OFF11	300	282	270	318	349	395	272	201	138	136	109	87	61	47	26	17	16	32	58	93	128	161	190	214
OFF14	300	282	270	318	349	395	272	201	138	136	109	87	61	47	26	17	16	32	58	93	128	161	190	214
OFF15	248	233	223	310	341	386	225	166	114	112	90	72	54	41	23	15	14	28	51	82	113	142	168	189
OFF18	248	233	223	310	341	386	225	166	114	112	90	72	54	41	23	15	14	28	51	82	113	142	168	189
OFF21	323	325	321	321	288	254	274	190	162	137	95	75	73	56	31	20	19	38	70	112	154	194	228	257
OFF21Q	323	325	321	321	288	254	274	190	162	137	95	75	73	56	31	20	19	38	70	112	154	194	228	257
GSEQ1	563	587	650	1049	1507	1521	544	333	364	437	271	214	169	130	72	47	44	88	161	259	356	447	527	593
GSEQ2	124	130	144	58	84	85	121	74	80	97	60	47	26	20	11	7	7	13	25	40	55	69	81	91
GSE	688	717	794	1108	1591	1605	664	406	444	534	331	262	195	149	83	54	50	101	186	299	411	516	607	684
GNWD1	644	697	770	996	1352	1368	752	652	678	567	341	262	191	147	81	53	49	99	182	293	403	506	596	671
GNWD2	891	930	993	1307	1693	1754	977	817	793	679	431	334	244	188	104	68	63	127	233	375	516	648	763	859
GNWQ1	704	736	773	678	547	485	428	302	234	224	238	129	212	163	90	59	55	110	202	325	447	562	661	745
GNWQ2	122	127	134	123	99	88	74	53	41	39	41	22	28	21	12	8	7	14	26	43	59	74	87	98
GNW	826	864	907	801	646	572	501	354	275	263	279	152	240	184	102	67	62	125	229	368	506	635	748	842
GSED	779	819	844	711	590	523	555	418	337	288	266	163	236	181	101	66	61	123	225	362	498	626	737	829
35NQ	382	461	424	441	392	354	390	326	214	158	153	123	111	85	47	31	29	58	106	171	235	295	347	391
35W	382	461	424	441	392	354	390	326	214	158	153	123	111	85	47	31	29	58	106	171	235	295	347	391
35SD	629	716	690	599	532	479	575	452	323	265	240	182	165	127	70	46	43	86	157	253	348	437	514	579
35SQ	462	563	630	894	792	860	879	1156	1170	605	336	240	165	127	71	46	43	86	158	253	349	438	516	580
35S	618	755	844	1023	906	984	1178	1548	1566	811	450	321	213	164	91	59	55	111	203	327	450	565	665	749
35ND1	519	602	573	775	794	744	511	405	289	239	206	165	152	117	65	42	39	79	146	234	322	405	476	536
35ND2	818	884	843	1092	1144	1139	782	605	428	375	316	252	213	164	91	59	55	111	204	327	451	566	666	750
35SQL	157	191	214	129	114	124	299	393	397	206	114	81	48	37	21	13	12	25	46	74	101	127	150	169
35NQL	93	112	103	112	100	90	95	79	53	39	37	30	30	23	13	8	8	16	29	46	63	79	93	105
35NQR	97	116	107	176	157	142	99	82	54	40	39	31	26	20	11	7	7	13	25	40	54	68	80	91

Table V-1(b)
Hourly link-specific traffic volumes at Thomas Road microscale intersection (1994)

	12 (noon	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10	11
27NBFF	975	899	1049	1102	1094	958	397	263	182	180	180	146	195	150	83	54	50	101	186	299	412	517	609	686
27NBD	867	976	1003	1066	1182	1009	480	272	355	289	209	149	201	154	86	56	52	104	191	308	424	532	626	705
27SBFF	645	611	815	807	954	1112	887	347	237	297	187	135	164	126	70	46	43	86	157	253	348	436	514	578
27SBD	538	542	584	598	693	765	669	303	180	156	117	110	127	98	54	35	33	66	121	195	268	337	397	447
THEBFF	789	785	759	772	725	681	545	385	317	283	302	145	188	144	80	52	49	98	179	288	397	498	587	661
THEBD	991	944	1016	975	924	897	695	459	393	423	410	190	240	184	102	67	62	125	229	368	506	636	748	843
THWBFF	1096	1130	1101	1226	1320	1313	846	643	526	493	349	210	249	191	106	69	64	129	237	382	525	660	777	875
THWBD	1040	1008	1119	1165	1261	1310	817	575	477	557	366	210	238	183	102	66	62	124	227	366	503	632	744	838
GRNWBFF	765	798	885	1234	1771	1788	739	453	494	594	368	291	217	166	93	60	56	113	207	333	458	575	676	762
GRNWBD	927	882	935	1427	1872	1912	804	539	389	413	299	279	231	177	99	64	60	120	220	354	488	612	721	812
GRSEBFF	882	922	968	855	689	611	535	378	292	280	298	162	256	196	109	71	66	133	244	393	540	678	798	899
GRSEBD	790	792	918	765	624	571	486	321	256	289	282	151	232	178	99	65	60	121	221	356	490	615	724	816
27NBLQ	196	161	186	179	178	162	84	61	35	32	31	32	34	26	14	9	9	18	32	52	71	89	105	118
27NBTQ	633	628	700	785	784	666	250	161	115	100	104	89	133	102	57	37	34	69	127	204	280	352	414	466
27NBRQ	145	110	162	138	132	131	63	41	33	48	45	25	29	22	12	8	7	15	27	44	60	76	89	101
27SBLQ	97	84	150	102	111	137	124	44	41	85	52	22	28	22	12	8	7	15	27	43	59	75	88	99
27SBTQ	378	365	444	462	564	654	553	216	128	124	84	79	93	71	40	26	24	48	89	143	196	246	290	327
27SBRQ	170	162	221	244	278	321	210	88	68	88	51	33	43	33	19	12	11	23	42	67	92	115	136	153
GRNWBLQ	104	99	123	125	165	171	87	59	62	101	59	38	26	20	11	7	7	13	24	39	54	68	80	90
GRNWBTQ	662	700	761	1109	1606	1617	654	393	432	494	310	253	191	147	82	53	49	99	182	293	404	507	596	672
GRSEBLQ	169	181	177	174	149	138	116	78	68	60	64	30	46	35	20	13	12	24	44	70	97	122	143	161
GRSEBTQ	713	741	791	681	540	473	418	300	225	221	234	131	210	161	90	58	54	109	200	322	443	556	655	738
THEBQ	789	785	759	772	725	681	545	385	317	283	302	145	188	144	80	52	49	98	179	288	397	498	587	661
THWBQ	1096	1130	1101	1226	1320	1313	846	643	526	493	349	210	249	191	106	69	64	129	237	382	525	660	777	875

was estimated based upon total signal cycle length and the net volumes traveling in each direction. Signal cycle length was obtained from local traffic engineering offices. For both intersections, the arrival type was set equal to the CAL3QHC default value and signal types were set to actuated. In addition, saturation flow rates of 2,000 vehicles per lane per hour was used for all movements, consistent with the Revised CO TSD [11].

V-4. Emission Rates

CAL3QHC requires running emission factors for free flow links and idling emission factors for queue links. MOBILE6 was used to determine emission factors for both moving vehicles and idling vehicles. A sample of the MOBILE6 input files used for the microscale analysis may be found in Appendix V. The free flow emission factors were obtained for the appropriate speed at each free flow link and temperature at each hour of the episode day. The roadway speed information is provided in Table V-2.

A full description of the derivation of the vehicle speeds may be found in Appendix III, Exhibit 3, Attachment One of the Revised CO TSD [11]. As previously indicated, the free flow speeds remain unchanged from the Revised CO TSD. Since MOBILE6 does not calculate idle emission factors directly, the idling emission factors were generated by running MOBILE6 at 2.5 miles per hour as recommended on page 41 of the Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation [33]. The output from that speed was then converted from grams per mile to grams per hour for input to CAL3QHC.

The MOBILE6 runs performed for input to CAL3QHC differ from those described in Appendix III as used with the M6Link model. The MOBILE6 runs performed for input to the M6Link model reflect the distribution of vehicle speeds predicted by the EMME/2 model for the area type and time of day being modeled. The MOBILE6 runs performed for input to CAL3QHC reflect speeds for the microscale intersection rather than a distribution of vehicle speeds as predicted by the EMME/2 transportation model. Both an I/M and a non-I/M run were performed and a weighted average of the two produced composite emission rates used in CAL3QHC.

V-5. Meteorology

The hourly meteorological inputs required by CAL3QHC are the following:

- Wind Speed,
- Wind Direction,
- Stability Class, and
- Mixing Height.

Table V-2. Vehicle free flow speeds by link.

Links	Speed (mph)
Grand Avenue	40
Indian School Road (west of Grand Ave.)	40
Indian School Road (east of Grand Ave.)	35
35th Avenue	35
27th Avenue	35
Thomas Road (west of Grand Ave.)	30
Thomas Road (east of Grand Ave.)	25
Ramps	25

These inputs, with the exception of stability class, are updated from the Moderate Area SIP [8] analysis to be consistent with the selection of the new episode day for the Serious Area SIP [10]. Air temperature is not a direct input to CAL3QHC, but influences the emission factors created by MOBILE6 which are directly input into the CAL3QHC model.

The hourly wind speed and direction for both intersections was obtained from data measured at the WISR monitoring station during the December 16-17, 1994 episode. Wind speeds of less than one meter per second were set to one meter per second as recommended by the User's Guide to CAL3QHC Version 2.0 (EPA, 1995) [25]. The accuracy of CAL3QHC is unproven at wind speeds below this value. The stability class was set to D stability (neutral) throughout the day and E stability (slightly stable) during the nighttime hours.

Mixing heights are consistent with those used in the UAM modeling. The hourly mixing height was assumed to remain constant across the seven grid cells which contain the intersections. It is important to note that CAL3QHC is only sensitive to mixing heights at extremely low values, much less than 100 meters.

The primary wind direction is from the south-southwest, therefore, the maximum concentrations are expected to occur towards the northeast quadrant of each intersection or to the northeast of a particularly congested section of roadway. The aerial photograph which was used to determine link geometry and receptor locations for the WISR intersection was rotated 225 degrees at the time of digitization for the Moderate Area SIP [8]. The orientation of the winds must match the orientation of the intersection geometry, therefore the winds at the WISR site were shifted 225 degrees to match the intersection geometry. The detailed meteorological inputs may be found in Table V-3.

Table V-3. Microscale Meteorological Inputs.

Hour	Temperature (°F)	Mixing Height (meters)	Wind Speed* (meters/sec)	Stability Class	Wind Direction PHGA	Wind Direction WISR
Noon-1 PM	61.8	190	0.5	4	214	79
1-2 PM	64.8	190	1.1	4	239	104
2-3 PM	66.6	190	1.1	4	265	130
3-4 PM	66.7	190	1.8	4	272	137
4-5 PM	65.2	184	1.2	4	273	138
5-6 PM	59.5	33	0.7	4	217	82
6-7 PM	55.3	22	0.1	5	198	63
7-8 PM	51.9	22	0.2	5	201	66
8-9 PM	49.7	22	0.2	5	195	60
9-10 PM	48.7	22	0.3	5	223	88
10-11 PM	47.7	22	0.2	5	224	89
11-MIDNIGHT	46.1	33	0.3	5	249	114
MIDNIGHT-1 AM	44.5	22	0.2	5	172	37
1-2 AM	43.3	22	0.5	5	142	7
2-3 AM	42.8	22	0.2	5	155	20
3-4 AM	41.9	22	0.2	5	162	27
4-5 AM	41.8	44	0.4	5	283	148
5-6 AM	41.0	44	0.1	5	162	27
6-7 AM	41.1	33	0.2	5	216	81
7-8 AM	40.5	44	0.3	4	177	42
8-9 AM	46.5	110	0.4	4	234	99
9-10 AM	55.0	110	0.3	4	198	63
10-11 AM	61.5	121	0.2	4	192	57
11-NOON	66.5	121	0.4	4	243	108

*All wind speeds of less than one meter per second are input to CAL3QHC as one meter per second.

SECTION VI. MODEL PERFORMANCE EVALUATION

Before the UAM can be used to assess the effectiveness of carbon monoxide maintenance strategies it must be demonstrated that the model adequately replicates the historical carbon monoxide episode (i.e., an acceptable base case simulation is achieved). This requires a careful and comprehensive evaluation of model performance. In this section the results of the base case simulation and a detailed summary of model performance are provided for the modeling episode.

Model performance for the episode was assessed using graphical and statistical analysis. Graphical analysis products included those recommended by EPA [21]: time-series plots of the observed and simulated pollutant concentrations, and contour plots showing isopleths of simulated pollutant concentrations and, where available, observed surface-layer concentrations. In addition, a scatter plot of predictions and observations was used to assess model performance.

EPA recommends that, at a minimum, the following three formulations be applied as measures for model performance evaluation: (A) unpaired (time or space) peak eight-hour prediction accuracy (equation (4)), (B) paired (time and space) mean absolute error in eight-hour peak prediction accuracy values greater than five ppm (equation (12)), and (C) paired (space only) mean absolute error in the predicted time of the eight-hour peak concentration value greater than five ppm.

In addition to the statistical measures documented in the EPA Guidance, further statistical analysis of the model results suggested in Tesche et. al. [27] were also performed and are presented in Tables VI-3(a) and (b). These include the paired (time and/or space) peak accuracy estimates (equations (1), (2), and (3)), the mean bias (equation (5)) and mean error at all stations (equations (9), (10), and (11)), and normalized bias (equations (6), (7), and (8)). The definitions of all the above measures are as follows:

Accuracy of Peak Estimates (%):

$$\textit{Paired Accuracy of the Peak, } A_{ts} = \frac{C_e(\bar{x},\bar{t}) - C_o(\bar{x},\bar{t})}{C_o(\bar{x},\bar{t})} \times 100\% \qquad \ldots (1)$$

$$\textit{Temporally-paired Accuracy of the Peak, } A_{t} = \frac{C_e(x,\bar{t}) - C_o(\bar{x},\bar{t})}{C_o(\bar{x},\bar{t})} \times 100\% \qquad \ldots (2)$$

$$Spatially\text{-}paired\ Accuracy\ of\ the\ Peak,\ A_s = \frac{C_e(\bar{x},t) - C_o(\bar{x},\bar{t})}{C_o(\bar{x},\bar{t})} \times 100\% \qquad \ldots (3)$$

$$Unpaired\ Accuracy\ of\ the\ Peak,\ A_u = \frac{C_e(x,t) - C_o(\bar{x},\bar{t})}{C_o(\bar{x},\bar{t})} \times 100\% \qquad \ldots (4)$$

Mean Bias:

$$At\ All\ Hours\ (ppm),\ B = \frac{1}{M \times N} \sum_{j=1}^{N} \sum_{i=1}^{M} (C_e(x_i,t_j) - C_o(x_i,t_j)) \qquad \ldots (5)$$

$$Normalized\ At\ All\ Hours\ (\%),\ B^* = \frac{1}{M \times N} \sum_{j=1}^{N} \sum_{i=1}^{M} \frac{(C_e(x_i,t_j) - C_o(x_i,t_j))}{C_o(x_i,t_j)} \qquad \ldots (6)$$

$$\begin{array}{c} Normalized\ At\ Peak\ Hour \\ (spatially\text{-}paired,\ \%) \end{array} B^*_s = \frac{1}{M} \sum_{i=1}^{M} \frac{(C_e(x_i,t_e) - C_o(x_i,t_o))}{C_o(x_i,t_o)} \qquad \ldots (7)$$

Mean Error:

$$Normalized\ At\ Peak\ Hour\ (paired,\ \%),\ B^*_{ts} = \frac{1}{M} \sum_{i=1}^{M} \frac{(C_e(x_i,t_o) - C_o(x_i,t_o))}{C_o(x_i,t_o)} \qquad \ldots (8)$$

$$At\ All\ Hours\ (ppm),\ E = \frac{1}{M \times N} \sum_{j=1}^{N} \sum_{i=1}^{M} |(C_e(x_i,t_j) - C_o(x_i,t_j))| \qquad \ldots (9)$$

$$Normalized\ At\ All\ Hours\ (\%),\ E^{*} = \frac{1}{M \times N} \sum_{j=1}^{N} \sum_{i=1}^{M} \frac{|(C_e(x_i,t_j) - C_o(x_i,t_j))|}{C_o(x_i,t_j)} \quad \ldots (10)$$

$$Normalized\ At\ Peak\ Hour\ (spatially\text{-}paired,\ \%),\ E^{*}_{s} = \frac{1}{M} \sum_{i=1}^{M} \frac{|(C_e(x_i,t_e) - C_o(x_i,t_o))|}{C_o(x_i,t_o)} \quad \ldots (11)$$

$$Normalized\ At\ Peak\ Hour\ (paired,\ \%),\ E^{*}_{ts} = \frac{1}{M} \sum_{i=1}^{M} \frac{|(C_e(x_i,t_o) - C_o(x_i,t_o))|}{C_o(x_i,t_o)} \quad \ldots (12)$$

where subscript *o* is for observations; subscript *e* is for estimations; overbar indicates pair in either space or time; *M* is the number of available stations, and *N* is the number of hours.

A cutoff of five ppm, per EPA guidance, was used for the statistical analysis. This was done to avoid excessive weighting of the low values and to avoid dividing by zero. In the calculation of the statistical measures, the weighted average of the predictions from the four grid cells nearest to the monitoring station was performed to provide collocated pairs of simulated and observed values. The four-cell weighted average is derived from bilinear interpolation as described in EPA [14].

VI-1. Base Case Simulation Results

The hourly concentrations output from the CAL3QHC model are incorporated into the UAM output processing. The modeling performance evaluation described in the following sections is based upon both UAM and CAL3QHC combined concentration fields and those with only UAM results.

The CAL3QHC model was used to produce estimates of the contribution of emissions from congested intersections to the CO levels at two hotspot locations: 35th-Grand-Indian School Road (WISR) and 27th-Grand-Thomas (PHGA). A network of receptors was modeled around each microscale intersection using CAL3QHC. A total of 120 points around the PHGA intersection were modeled and a total of 180 points around the WISR intersection were modeled. At each intersection, one receptor was located at the coordinates of the actual monitor. Depending upon the exact location of the receptor around the intersection, each receptor may have been located in any of several UAM grid cells, each with a unique modeled CO concentration.

The CO concentration modeled at each of the 300 receptors using the CAL3QHC program is combined with the UAM background concentration modeled for the grid cell containing the particular receptor. The result is a net CO concentration for each of the 300 receptors.

Table VI-1. Combined UAM/CAL3QHC maximum eight-hour concentrations (ppm) in the Maricopa County area for the December 16-17, 1994 base case.

Location	UAM Grid Cell	UAM Concentration	CAL3QHC Concentration	Total	Ending Hour
WISR Monitor	(11,15)	7.25	0.06	7.31	0400
WISR Receptor # 9	(11,15)	6.74	2.00	8.74	0200
WISR Receptor # 10	(11,16)	7.76	0.65	8.41	0400
WISR Receptor # 21	(11,16)	7.46	0.90	8.36	0300
PHGA Monitor	(11,15)	7.19	0.53	7.72	0300
PHGA Receptor # 76	(12,14)	8.04	1.71	9.75	0300
PHGA Receptor # 74	(12,15)	7.82	1.69	9.51	0300
PHGA Receptor # 46	(12,14)	8.04	1.46	9.50	0200
UAM Maximum	(15,13)	10.71	-	10.71	0300

The maximum three net concentrations around each of the two intersections and the net concentration modeled at the actual monitor located at each intersection are reported in Table VI-1. The intersections selected for the microscale modeling were those at which high CO concentrations have historically been recorded. Both intersections are six-legged, congested intersections where long queues of idling vehicles build up during peak hours. These intersections are both located in the western portion of the modeling domain. In addition, peak UAM concentrations occur very close to these intersections consistently for the years modeled.

VI-1-1. GRAPHICAL ANALYSIS

Hourly isopleth plots of the simulated eight-hour carbon monoxide concentrations for December 16 and 17, 1994 (Friday-Saturday) between the hours of 2100 and 1200 MST are provided in Appendix VI, Exhibits 4 (with microscale components) and 5 (without microscale components). Plots of the maximum simulated (with and without the microscale component) and observed carbon monoxide eight-hour concentrations for 1994 are provided in Figures VI-1(a) and VI-1(b). The simulated carbon monoxide concentrations build up gradually over Maricopa County in the northwest-southeast orientation. Simulated maximum eight-hour carbon monoxide concentrations over the urban area range from approximately five to ten parts per million (ppm) and are in good agreement with the observations. The higher concentrations are simulated during the midnight hours, especially in the central area of the region. The regional maximum simulated carbon monoxide eight-hour concentration for this episode is 10.71 ppm (with and without the microscale component) and occurs in southeast of Central and McDowell Roads. The monitoring site where the peak eight-hour concentration of 10.5 ppm ending at 0300 MST was observed is at West Indian School Road (WISR). The locations of the simulated peak is within a few miles of the location where the peak was observed (WISR). This indicates that the UAM modeling is capable of replicating the occurrence of high CO concentrations.

The scatter plots in Figure VI-2 were developed by plotting all eight-hour average simulated-observed pairs. The solid diagonal line is the perfect correlation line and the dashed lines enclose the region wherein estimates and observations agree within a factor of two. Most of the data points are located in this region.

Time-series plots illustrating the simulated and observed carbon monoxide eight-hour concentrations at stations throughout the modeling region are provided in Figure VI-3 (a-f). In general, good agreement is achieved over most of the urban area but simulated carbon monoxide concentrations over MESA and SSCT are somewhat higher than observed. The time-series plots indicate reasonable model performance of CO patterns with time.

VI-1-2. STATISTICAL ANALYSIS

In this section, the performance of the UAM for the episode is quantified using the statistical measures of accuracy, error, and bias presented previously. The resulting statistical performance measures for each of the episode days were then compared with

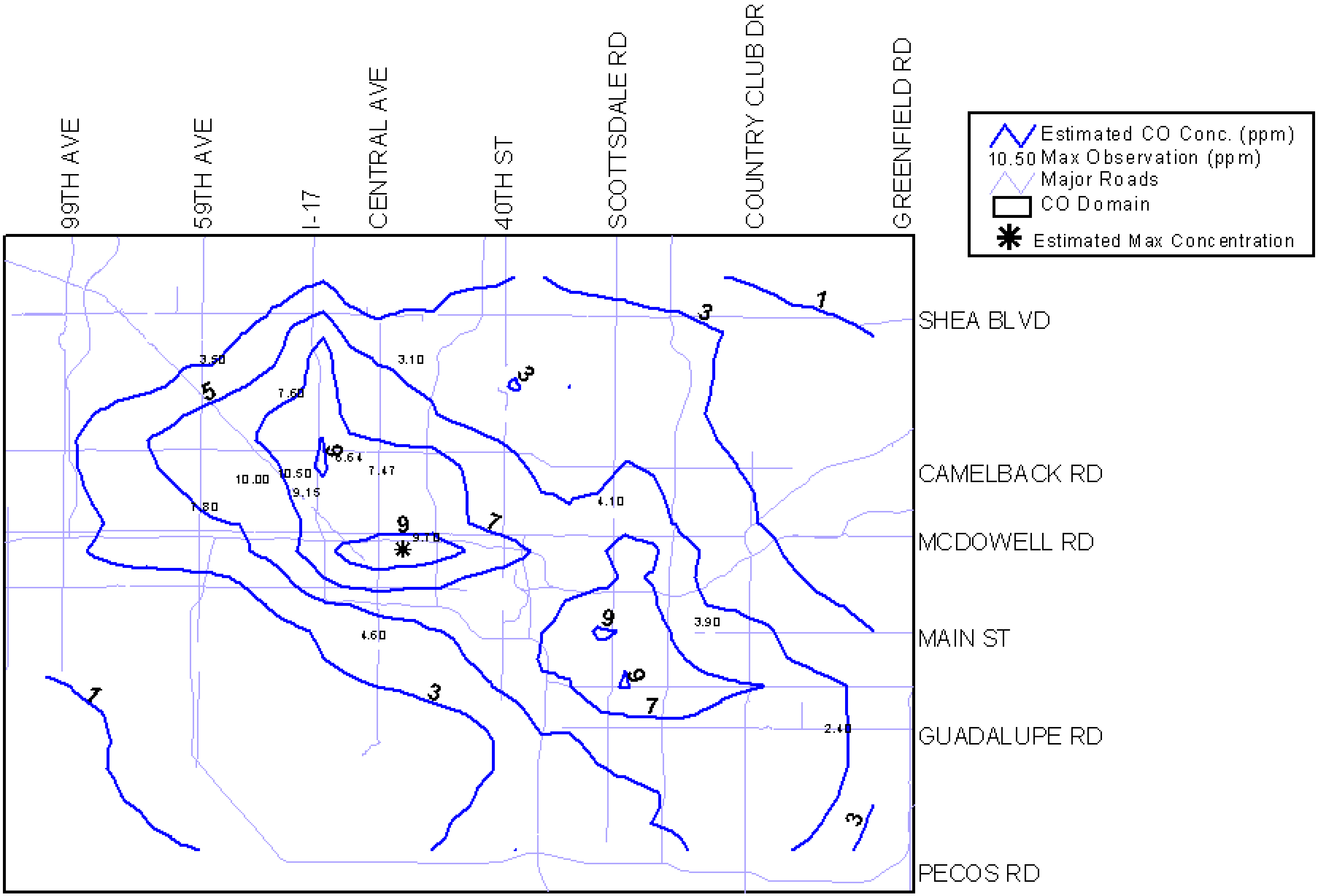


Figure VI-1(a) Maximum simulated and observed 8-hour CO concentrations for 1994 (without microscale components, max conc = 10.71 ppm at (15,13)).

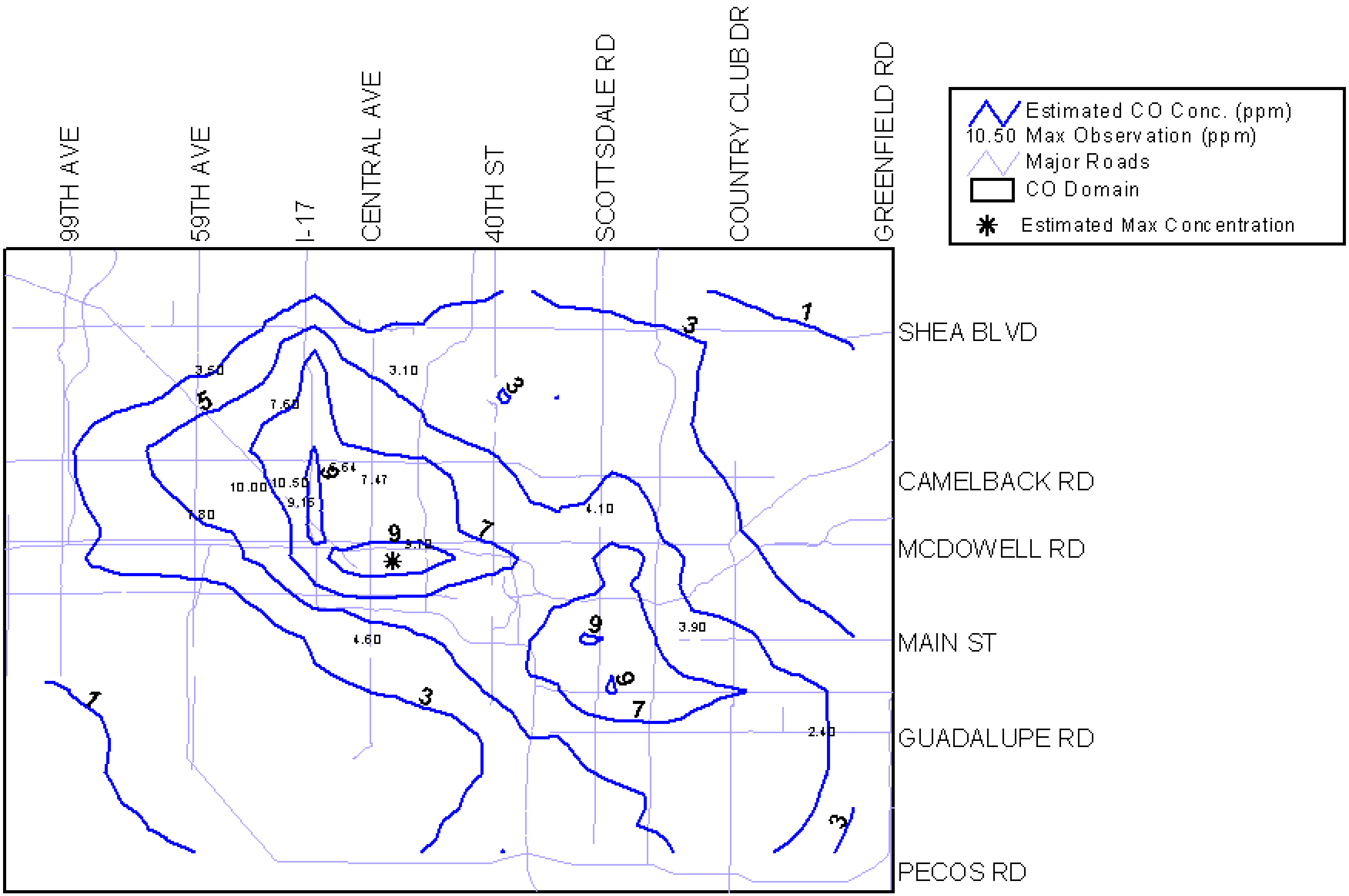
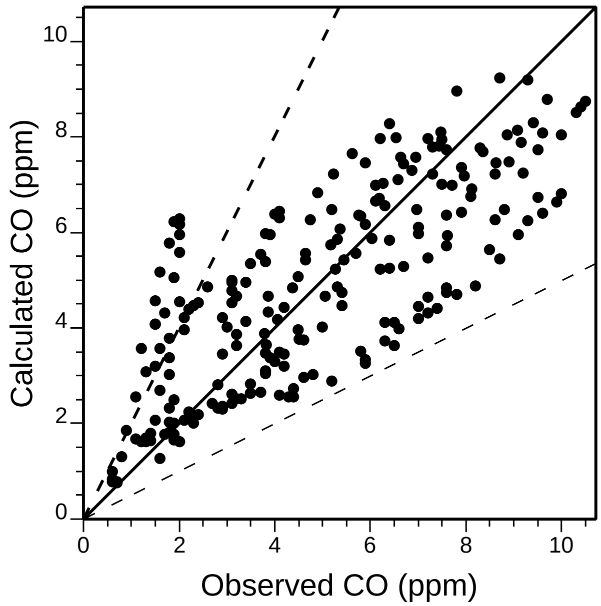
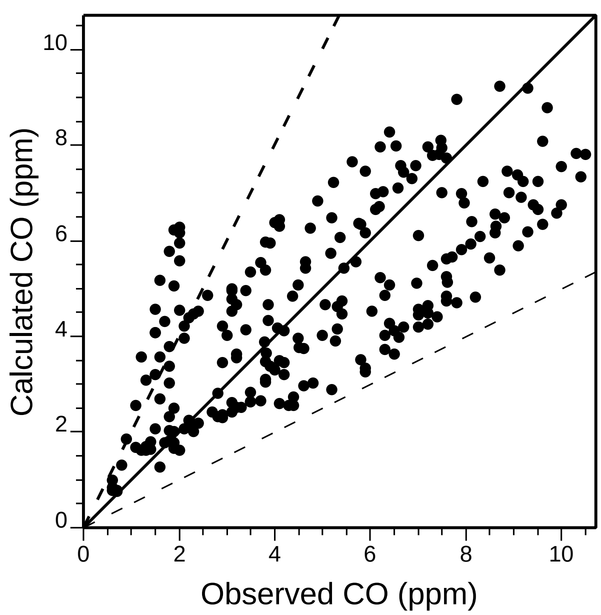


Figure VI-1(b) Maximum simulated and observed 8-hour CO concentrations for 1994 (with microscale components, max conc = 10.71 ppm at (15,13)).



(a) Simulated concentrations are from UAM combined with microscale modeling.



(b) Simulated concentrations are from UAM only.

Figure VI-2. Scatter plots showing all 8-hour average simulated-observed pairs.

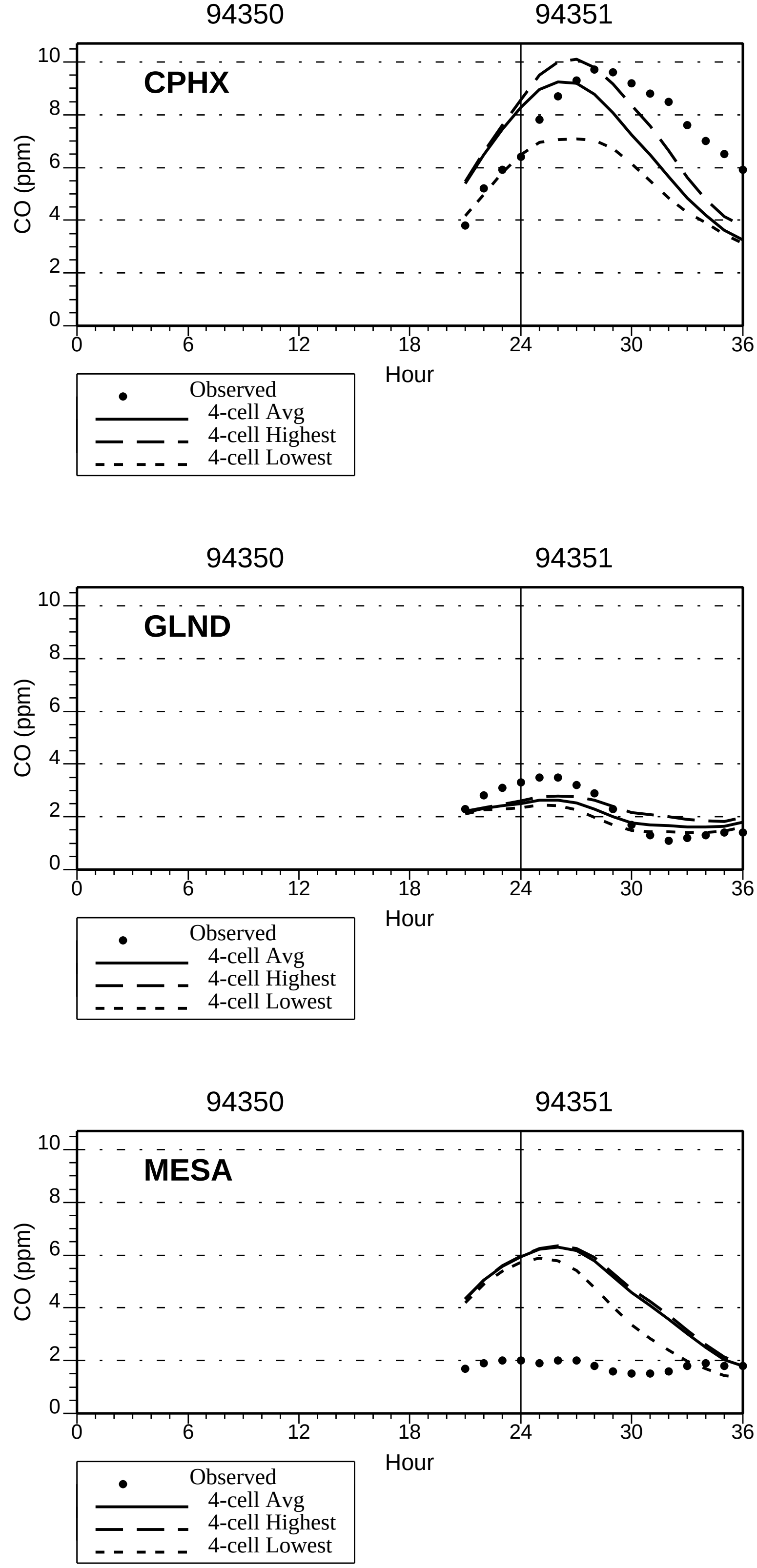
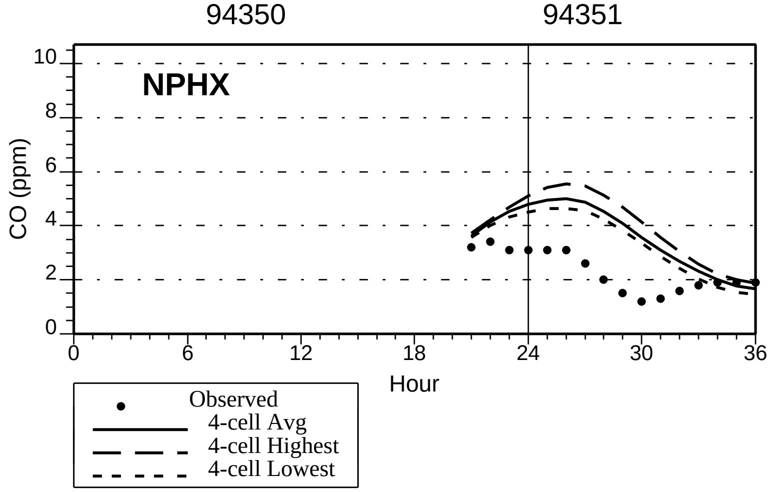
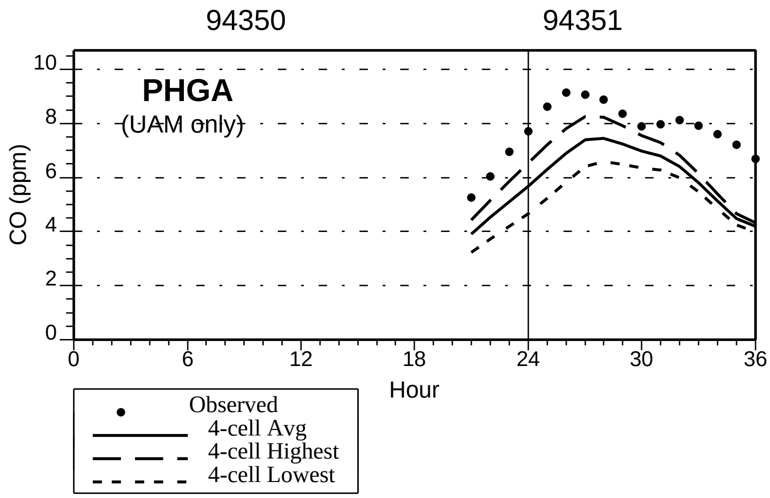


Figure VI-3(a). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region.





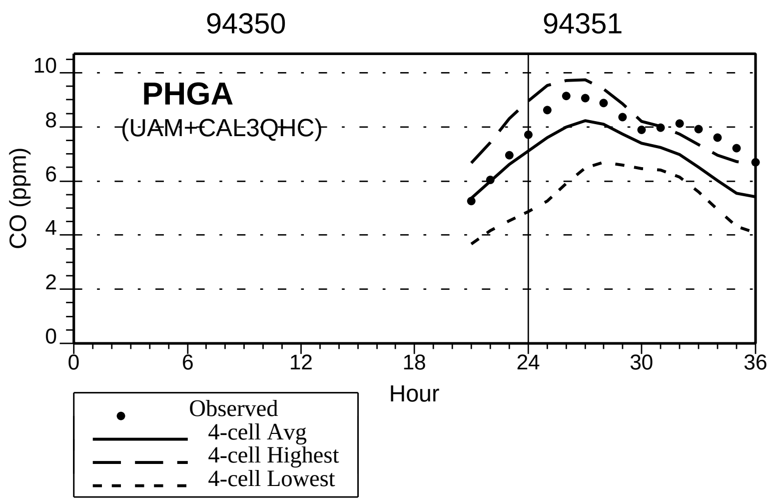
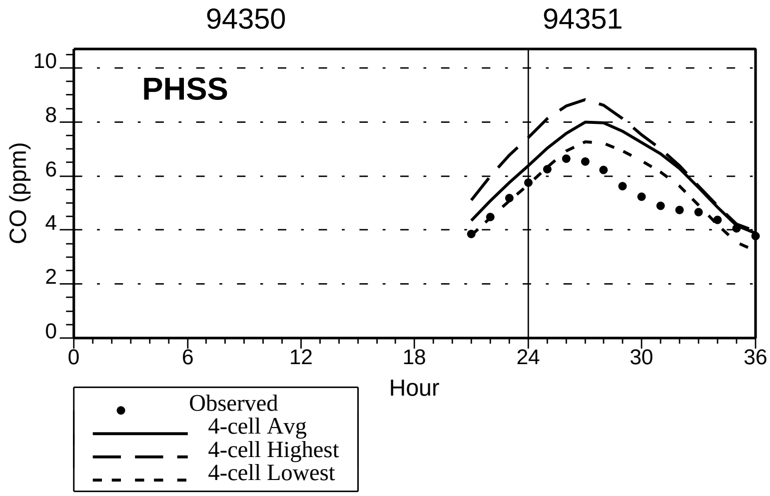
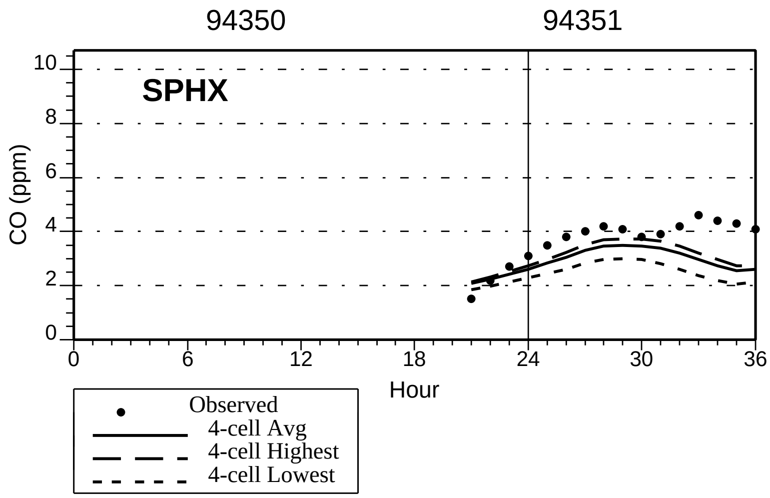


Figure VI-3(b). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region (continued).





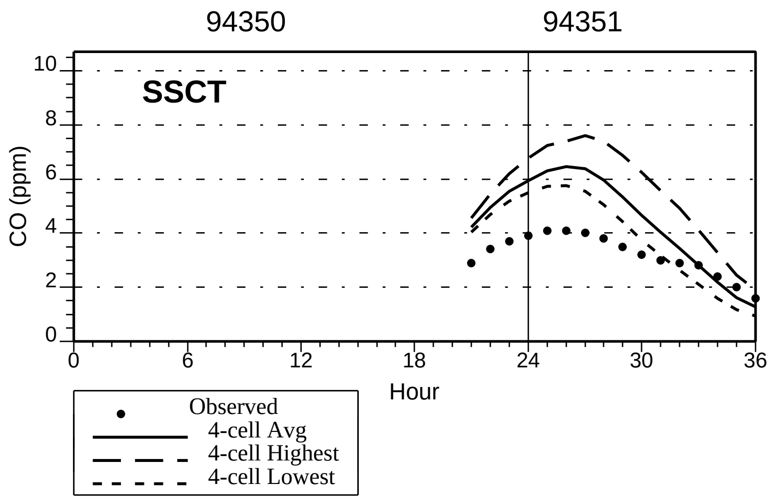


Figure VI-3(c). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region (continued).

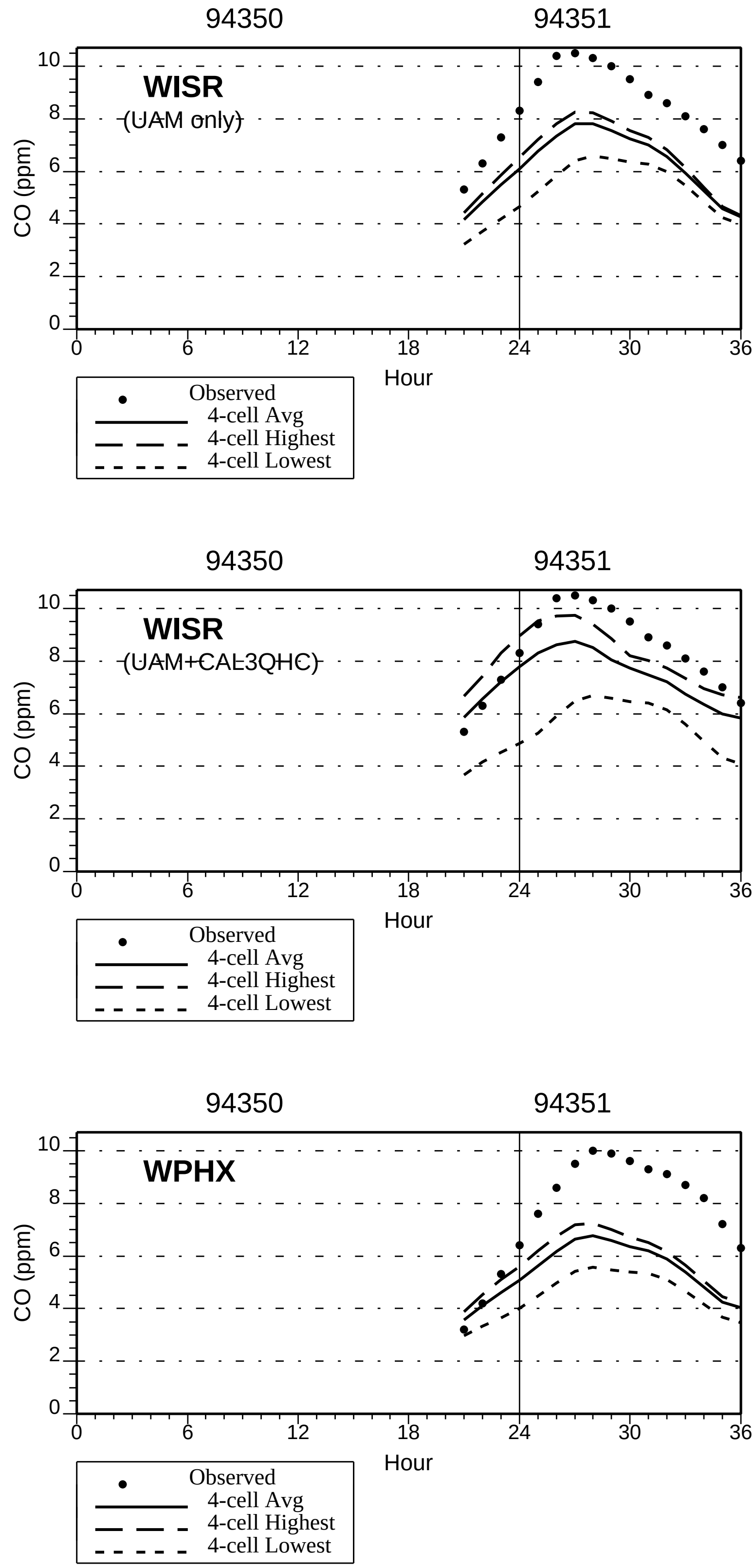
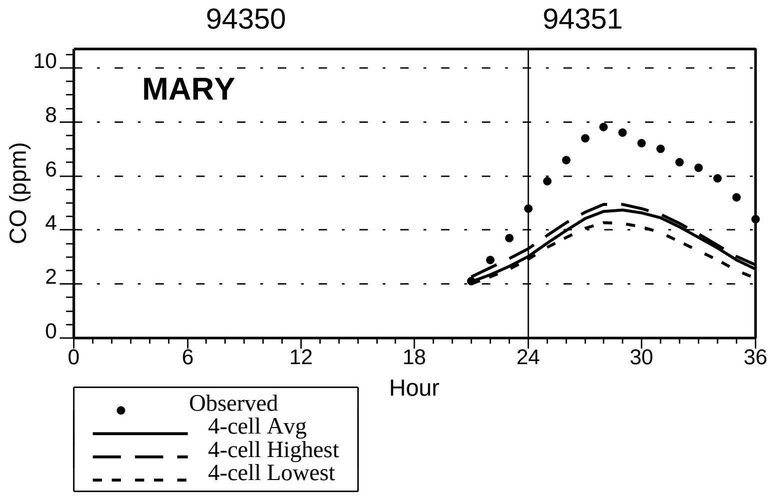
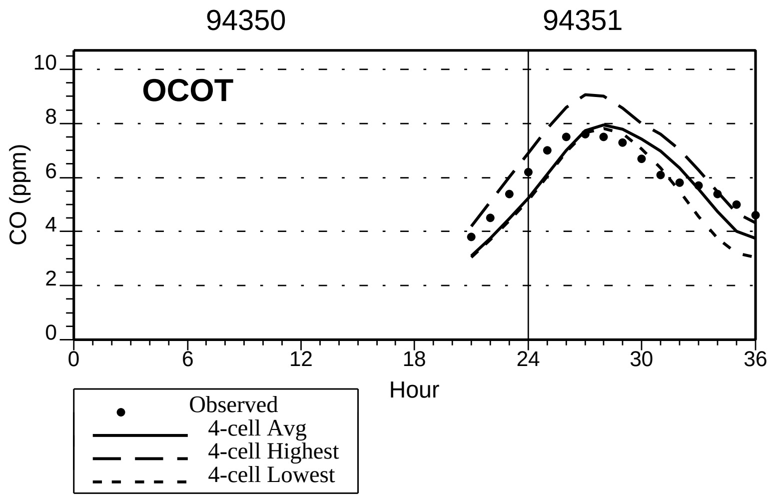


Figure VI-3(d). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region (continued).





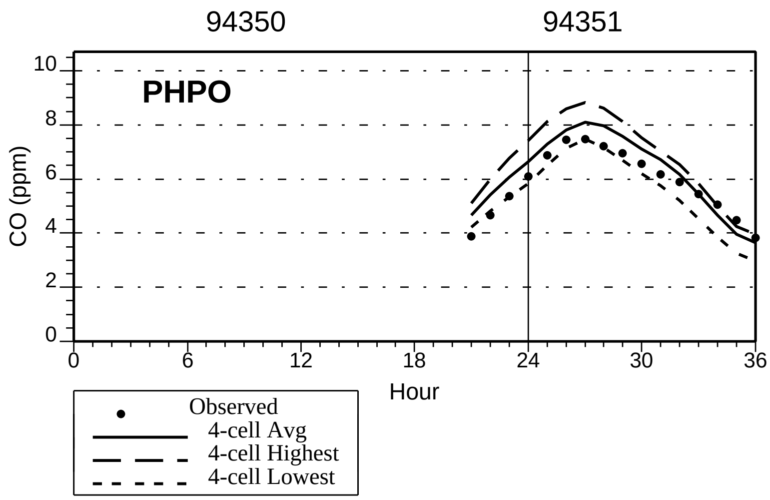


Figure VI-3(e). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region (continued).

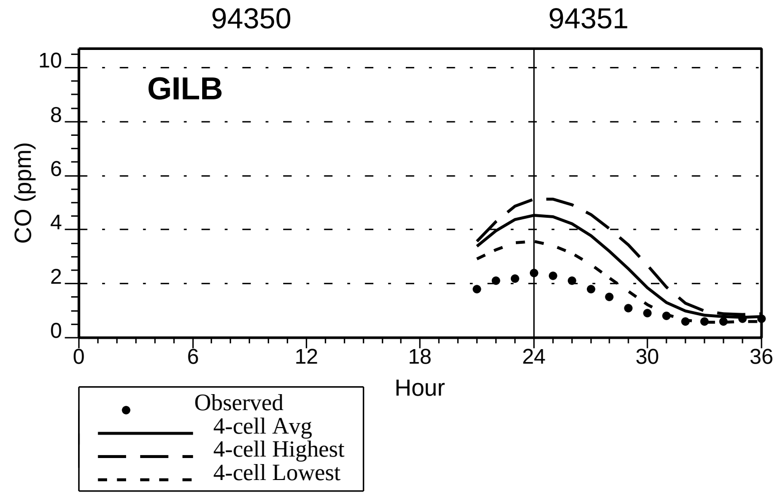


Figure VI-3(f). Time-series plot illustrating the simulated and observed 8-hour carbon monoxide concentration at available stations throughtout the modeling region (concluded).

the general ranges provided in the UAM guidance document [21] for acceptable model performance.

Tables VI-2 (a-p) summarize observed and calculated eight-hour average concentrations for the 14 stations. Additional statistical measures together with those recommended by EPA guidance, as described in Equations (1) to (12), are summarized in Tables VI-3(a) & (b). The simulated results are shown with and without the results from the CAL3QHC microscale modeling study.

The statistical measures indicate good agreement between the simulated and observed concentrations at most sites. The mean normalized bias at all hours (equation (6)) is -10 or -15 percent, with or without the microscale component included, indicating that the model tends to slightly underestimate CO concentrations. The mean normalized error at all hours (equation (10)) is 18 or 22 percent, with or without the microscale component included. This indicates that the noise of the simulated-observed paired comparison at all hours is still below the EPA standard (30%) for the peak-hour comparison.

The mean absolute error of the simulated peak eight-hour concentration for all monitoring sites paired in both space and time (equation (12)) is 17.01 or 19.53 percent, with or without the microscale component included, indicating that the relatively high peak concentrations that were observed on this day are well represented in reference to the EPA recommended range. The simulated peak carbon monoxide eight-hour concentration (unpaired in space and time, equation (4)) is 1.99 percent higher than the maximum observation either with or without the microscale component included, and occurs in an the busy downtown area where higher concentrations have generally been observed. The mean absolute error in the predicted time of the eight-hour peak concentration (paired in space) is 0.75 or 1 hour, with or without the microscale component included, which is also less than the two hours recommended by EPA.

Table VI-2(a~p). Observed and UAM simulated eight-hour average CO concentrations at the 14 monitoring stations.

Phoenix Grand Avenue (PHGA)[4]

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg		Observed		Error_(%)[1]	Lag_(hr)
21[3]	4.42	3.23	3.90		5.27		-26.07	
22	5.16	3.72	4.53		6.04		-25.05	
23	5.86	4.19	5.11		6.96		-26.55	
24	6.52	4.65	5.67		7.71		-26.48	
1	7.22	5.23	6.31		8.63		-26.88	
2	7.82	5.84	6.90		9.15		-24.57	
3	8.25	6.40	7.38		9.07		-18.60	
4	8.23	6.59	7.46		8.87		-15.93	
5	7.91	6.49	7.24		8.35		-13.33	
6	7.56	6.35	6.98		7.90		-11.59	
7	7.28	6.28	6.80		7.97		-14.69	
8	6.83	5.99	6.41		8.12		-21.06	
9	6.14	5.46	5.81		7.91		-26.59	
10	5.40	4.85	5.14		7.61		-32.44	
11	4.67	4.24	4.49		7.21		-37.78	
12	4.33	4.00	4.20		6.69		-37.24	
MAX[2]			7.46	4	9.15	2	-18.5	2

1 Error = (4_Cell_Avg - Observed)/Observed *100, paired in time and space.

2 The maximum numbers are not paired in time.

3 To minimize propagation of error from the initial hour, the first simulation hour was discarded.

4 This site is selected for hotspot analysis. The analysis here does not include results from the CAL3QHC. study.

Table VI-2(b)

Phoenix Grand Avenue (PHGA)[1]

Ending _Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	6.65	3.67	5.36	5.27	1.67	
22	7.43	4.16	5.99	6.04	-0.81	
23	8.30	4.54	6.61	6.96	-5.08	
24	8.96	4.86	7.11	7.71	-7.82	
1	9.52	5.26	7.61	8.63	-11.81	
2	9.70	5.91	8.00	9.15	-12.55	
3	9.75	6.49	8.23	9.07	-9.22	
4	9.40	6.68	8.11	8.87	-8.57	
5	8.86	6.59	7.75	8.35	-7.24	
6	8.21	6.46	7.40	7.90	-6.31	
7	8.02	6.39	7.23	7.97	-9.25	
8	7.73	6.15	6.97	8.12	-14.21	
9	7.33	5.60	6.51	7.91	-17.76	
10	6.96	4.94	6.02	7.61	-20.91	
11	6.71	4.32	5.56	7.21	-22.93	
12	6.62	4.08	5.41	6.69	-19.08	
	MAX		8.23 3	9.15 2	-10.01	1

[1] This site is selected for hotspot analysis. The analysis here includes results from the CAL3QHC study.

Table VI-2(c)

Phoenix Post Office (PHPO)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	5.11	4.22	4.67	3.87	20.73	
22	5.99	4.82	5.42	4.65	16.63	
23	6.76	5.34	6.07	5.37	13.07	
24	7.43	5.83	6.65	6.1	8.98	
1	8.13	6.5	7.3	6.87	6.29	
2	8.59	7.12	7.82	7.44	5.05	
3	8.83	7.47	8.1	7.47	8.45	
4	8.63	7.17	7.96	7.2	10.6	
5	8.11	6.7	7.56	6.95	8.84	
6	7.51	6.21	7.11	6.57	8.25	
7	7.03	5.76	6.71	6.18	8.55	
8	6.55	5.22	6.17	5.89	4.7	
9	5.82	4.54	5.43	5.44	-0.12	
10	5	3.86	4.66	5.05	-7.78	
11	4.24	3.26	3.97	4.49	-11.62	
12	3.95	2.96	3.65	3.83	-4.58	
	MAX		8.1 3	7.47 3	8.45	0

Table VI-2(d)

Phoenix Supersite (PHSS)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	5.11	3.82	4.34	3.86	12.37	
22	5.99	4.45	5.07	4.48	13.12	
23	6.76	5.07	5.74	5.17	11.08	
24	7.43	5.68	6.37	5.75	10.74	
1	8.13	6.33	7.03	6.26	12.34	
2	8.59	6.92	7.58	6.64	14.14	
3	8.83	7.26	7.98	6.54	22.09	
4	8.63	7.22	7.97	6.21	28.29	
5	8.11	6.92	7.65	5.62	36.04	
6	7.51	6.56	7.23	5.23	38.22	
7	7	6.14	6.82	4.9	39.24	
8	6.39	5.61	6.27	4.74	32.29	
9	5.63	4.93	5.57	4.65	19.75	
10	4.9	4.2	4.84	4.38	10.58	
11	4.22	3.53	4.17	4.06	2.69	
12	3.95	3.23	3.88	3.78	2.59	
	MAX		7.98 3	6.64 2	20.25	1

Table VI-2(e)

Central Phoenix (CPHX)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	5.47	4.16	5.38	3.8	41.63	
22	6.58	4.98	6.47	5.2	24.44	
23	7.6	5.81	7.45	5.9	26.24	
24	8.57	6.47	8.27	6.4	29.24	
1	9.5	6.94	8.96	7.8	14.84	
2	10.01	7.06	9.24	8.7	6.18	
3	10.11	7.07	9.19	9.3	-1.23	
4	9.8	7.03	8.78	9.7	-9.47	
5	9.15	6.71	8.07	9.6	-15.89	
6	8.37	6.14	7.25	9.2	-21.21	
7	7.58	5.51	6.47	8.8	-26.45	
8	6.64	4.84	5.65	8.5	-33.56	
9	5.62	4.29	4.84	7.6	-36.35	
10	4.8	3.9	4.2	7	-40.01	
11	4.13	3.47	3.63	6.5	-44.16	
12	3.77	3.13	3.26	5.9	-44.79	
	MAX		9.24 2	9.7 4	-4.77	-2

Table VI-2(f)

South Scottsdale (SSCT)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	4.56	4.04	4.21	2.9	45.14	
22	5.44	4.69	4.96	3.4	45.85	
23	6.2	5.18	5.55	3.7	49.95	
24	6.78	5.49	5.95	3.9	52.51	
1	7.24	5.74	6.3	4.1	53.57	
2	7.4	5.77	6.45	4.1	57.29	
3	7.61	5.55	6.38	4	59.41	
4	7.39	5.05	5.97	3.8	57.02	
5	6.88	4.42	5.35	3.5	52.79	
6	6.24	3.76	4.66	3.2	45.5	
7	5.58	3.17	4.03	3	34.2	
8	4.92	2.64	3.44	2.9	18.79	
9	4.12	2.1	2.81	2.8	0.18	
10	3.28	1.6	2.18	2.4	-9.36	
11	2.44	1.18	1.61	2	-19.39	
12	1.89	0.95	1.27	1.6	-20.58	
	MAX		6.45 2	4.1 2	57.29	0

Table VI-2(g)

Glendale (GLND)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	2.23	2.12	2.17	2.3	-5.62	
22	2.36	2.25	2.33	2.8	-16.78	
23	2.48	2.29	2.41	3.1	-22.25	
24	2.61	2.35	2.51	3.3	-23.93	
1	2.76	2.44	2.63	3.5	-24.84	
2	2.8	2.41	2.63	3.5	-24.94	
3	2.77	2.28	2.52	3.2	-21.29	
4	2.64	1.99	2.3	2.9	-20.71	
5	2.4	1.69	2.01	2.3	-12.75	
6	2.16	1.5	1.78	1.7	4.93	
7	2.07	1.44	1.7	1.3	31.11	
8	2.01	1.42	1.68	1.1	52.54	
9	1.91	1.4	1.63	1.2	35.63	
10	1.84	1.41	1.61	1.3	23.82	
11	1.83	1.46	1.64	1.4	17.23	
12	1.97	1.62	1.8	1.4	28.31	
	MAX		2.63 1	3.5 2	-24.84	-1

Table VI-2(h)

West Phoenix (WPHX)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	3.89	2.96	3.56	3.2	11.2	
22	4.53	3.33	4.12	4.2	-1.84	
23	5.1	3.65	4.62	5.3	-12.81	
24	5.6	4	5.07	6.4	-20.72	
1	6.18	4.47	5.62	7.6	-26.06	
2	6.74	4.96	6.17	8.6	-28.21	
3	7.19	5.41	6.65	9.5	-30	
4	7.25	5.56	6.76	10	-32.41	
5	7.01	5.48	6.58	9.9	-33.55	
6	6.72	5.39	6.35	9.6	-33.87	
7	6.51	5.34	6.19	9.3	-33.41	
8	6.17	5.1	5.89	9.1	-35.31	
9	5.64	4.66	5.39	8.7	-38.01	
10	5.05	4.17	4.82	8.2	-41.23	
11	4.46	3.67	4.25	7.2	-40.93	
12	4.22	3.45	4.02	6.3	-36.13	
	MAX		6.76 4	10 4	-32.41	0

Table VI-2(i)

North Phoenix (NPHX)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	3.71	3.56	3.62	3.2	13.21	
22	4.21	4.01	4.13	3.4	21.44	
23	4.69	4.33	4.53	3.1	46.29	
24	5.09	4.5	4.79	3.1	54.39	
1	5.41	4.62	4.96	3.1	59.85	
2	5.55	4.65	4.99	3.1	60.89	
3	5.47	4.55	4.86	2.6	86.97	
4	5.14	4.25	4.54	2	126.96	
5	4.68	3.83	4.09	1.5	172.34	
6	4.14	3.35	3.57	1.2	197.53	
7	3.58	2.86	3.09	1.3	137.43	
8	3.05	2.42	2.69	1.6	67.85	
9	2.58	2.04	2.32	1.8	29.03	
10	2.22	1.72	2.02	1.9	6.08	
11	2	1.52	1.78	1.9	-6.47	
12	1.86	1.47	1.66	1.9	-12.39	
	MAX		4.99 2	3.4 22	46.69	4

Table VI-2(j)

Mesa (MESA)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	4.34	4.2	4.31	1.7	153.75	
22	5.06	4.89	5.05	1.9	165.81	
23	5.59	5.39	5.58	2	178.99	
24	5.96	5.72	5.95	2	197.25	
1	6.26	5.89	6.23	1.9	227.9	
2	6.34	5.77	6.29	2	214.59	
3	6.26	5.41	6.17	2	208.45	
4	5.9	4.78	5.78	1.8	220.98	
5	5.31	4.04	5.17	1.6	223.12	
6	4.72	3.36	4.58	1.5	205.01	
7	4.24	2.83	4.08	1.5	172.09	
8	3.73	2.38	3.58	1.6	123.54	
9	3.16	1.99	3.02	1.8	67.99	
10	2.61	1.68	2.5	1.9	31.36	
11	2.13	1.44	2.04	1.8	13.15	
12	1.88	1.35	1.81	1.8	0.54	
	MAX		6.29	2 2	3 214.59	-1

Table VI-2(k)

West Indian School Road (WISR)[1]

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg		Observed		Error_(%)	Lag_(hr)
21	4.42	3.23	4.16		5.3		-21.46	
22	5.16	3.72	4.85		6.3		-23	
23	5.86	4.19	5.49		7.3		-24.79	
24	6.52	4.65	6.09		8.3		-26.6	
1	7.22	5.23	6.76		9.4		-28.1	
2	7.82	5.84	7.35		10.4		-29.36	
3	8.25	6.4	7.8		10.5		-25.74	
4	8.23	6.59	7.82		10.3		-24.05	
5	7.91	6.49	7.55		10		-24.47	
6	7.56	6.35	7.25		9.5		-23.71	
7	7.28	6.28	7		8.9		-21.35	
8	6.83	5.99	6.56		8.6		-23.74	
9	6.14	5.46	5.93		8.1		-26.85	
10	5.4	4.85	5.25		7.6		-30.96	
11	4.67	4.24	4.57		7		-34.66	
12	4.33	4	4.27		6.4		-33.35	
	MAX		7.82	4	10.5	3	-25.5	1

1 This site is selected for hotspot analysis. The analysis here does not include results from the CAL3QHC study.

Table VI-2(l)

West Indian School Road (WISR)[1]

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg		Observed		Error_(%)	Lag_(hr)
21.00	6.65	3.67	5.85		5.30		10.32	
22.00	7.43	4.16	6.55		6.30		3.97	
23.00	8.30	4.54	7.21		7.30		-1.19	
24.00	8.96	4.86	7.78		8.30		-6.30	
1.00	9.52	5.26	8.30		9.40		-11.73	
2.00	9.70	5.91	8.63		10.40		-17.02	
3.00	9.75	6.49	8.74		10.50		-16.80	
4.00	9.40	6.68	8.50		10.30		-17.43	
5.00	8.86	6.59	8.04		10.00		-19.60	
6.00	8.21	6.46	7.72		9.50		-18.70	
7.00	8.02	6.39	7.48		8.90		-15.90	
8.00	7.73	6.15	7.21		8.60		-16.11	
9.00	7.33	5.60	6.75		8.10		-16.68	
10.00	6.96	4.94	6.36		7.60		-16.30	
11.00	6.71	4.32	5.98		7.00		-14.63	
12.00	6.62	4.08	5.84		6.40		-8.74	
	MAX		8.74	3	10.50	3	-16.80	0

[1] This site is selected for hotspot analysis. The analysis here includes results from the CAL3QHC study.

Table VI-2(m)

South Phoenix (SPHX)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg		Observed		Error_(%)	Lag_(hr)
21	2.14	1.84	2.08		1.5		38.39	
22	2.31	1.97	2.24		2.2		1.76	
23	2.52	2.13	2.42		2.7		-10.29	
24	2.73	2.28	2.61		3.1		-15.71	
1	2.97	2.44	2.83		3.5		-19.24	
2	3.23	2.61	3.04		3.8		-19.89	
3	3.52	2.84	3.3		4		-17.44	
4	3.69	2.97	3.45		4.2		-17.77	
5	3.73	3.01	3.49		4.1		-14.9	
6	3.71	2.96	3.47		3.8		-8.76	
7	3.65	2.82	3.38		3.9		-13.32	
8	3.46	2.61	3.19		4.2		-24.03	
9	3.21	2.38	2.96		4.6		-35.74	
10	2.96	2.19	2.74		4.4		-37.77	
11	2.74	2.05	2.56		4.3		-40.41	
12	2.73	2.13	2.59		4.1		-36.74	
	MAX		3.49	5	4.6	9	-24.15	-4

Table VI-2(n)

Gilbert (GILB)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg		Observed		Error_(%)	Lag_(hr)
21	3.56	2.91	3.38		1.8		87.67	
22	4.31	3.24	3.97		2.1		89.09	
23	4.86	3.51	4.38		2.2		99.28	
24	5.13	3.56	4.53		2.4		88.75	
1	5.14	3.4	4.47		2.3		94.18	
2	4.92	3.11	4.21		2.1		100.31	
3	4.55	2.7	3.79		1.8		110.29	
4	4.05	2.2	3.21		1.5		113.97	
5	3.43	1.73	2.56		1.1		132.56	
6	2.67	1.22	1.85		0.9		105.7	
7	1.87	0.85	1.3		0.8		62.75	
8	1.28	0.65	0.99		0.6		65.42	
9	1	0.58	0.84		0.6		39.82	
10	0.89	0.57	0.78		0.6		29.57	
11	0.85	0.59	0.76		0.7		8.87	
12	0.88	0.61	0.79		0.7		12.16	
	MAX		4.53	24	2.4	24	88.75	0

Table VI-2(o)

Maryvale (MARY)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	2.27	2	2.07	2.1	-1.25	
22	2.6	2.26	2.35	2.9	-18.9	
23	2.94	2.56	2.66	3.7	-28.03	
24	3.3	2.93	3.03	4.8	-36.91	
1	3.79	3.35	3.52	5.8	-39.34	
2	4.26	3.72	3.98	6.6	-39.62	
3	4.67	4.07	4.42	7.4	-40.3	
4	4.94	4.28	4.7	7.8	-39.79	
5	4.93	4.26	4.74	7.6	-37.64	
6	4.79	4.11	4.64	7.2	-35.61	
7	4.59	3.9	4.45	7	-36.44	
8	4.25	3.58	4.12	6.5	-36.62	
9	3.85	3.22	3.73	6.3	-40.8	
10	3.44	2.89	3.33	5.9	-43.57	
11	3.01	2.51	2.89	5.2	-44.48	
12	2.7	2.22	2.56	4.4	-41.86	
	MAX		4.74 5	7.8 4	-39.24	1

Table VI-2(p)

Ocotillo (OCOT)

Ending_Hr	4_Cell_Hi	4_Cell_Lo	4_Cell_Avg	Observed	Error_(%)	Lag_(hr)
21	4.19	3.05	3.1	3.8	-18.36	
22	5.09	3.7	3.76	4.5	-16.46	
23	6.01	4.41	4.48	5.4	-17.09	
24	6.89	5.16	5.23	6.2	-15.57	
1	7.81	6.05	6.11	7	-12.65	
2	8.59	6.95	7.01	7.5	-6.54	
3	9.07	7.64	7.73	7.6	1.7	
4	9.01	7.82	7.95	7.5	6.04	
5	8.57	7.63	7.79	7.3	6.74	
6	7.99	7.06	7.43	6.7	10.85	
7	7.6	6.35	6.99	6.1	14.51	
8	7.02	5.49	6.35	5.8	9.49	
9	6.27	4.57	5.56	5.7	-2.43	
10	5.48	3.74	4.74	5.4	-12.25	
11	4.7	3.2	4.02	5	-19.67	
12	4.33	3.04	3.74	4.6	-18.72	
	MAX		7.95 4	7.6 3	4.64	1

Table VI-3(a). Summary of performance evaluation statistics for modeling results of UAM only for eight-hour averages.

Observed max = 10.50 at WISR on Julian day 94351 hour 0300

cut off = 5. ppm

	Accuracy of Peak Estimates (%)			
	Paired	T-Paired	S-Paired	Unpaired
Equation No.	(1)	(2)	(3)	(4)
Conc (ppm)	7.80	10.71	7.82	10.71
X-cell	11	15	11	15
y-cell	15	13	15	13
Date	94351	94351	94351	94351
Hour	0300	0300	0400	0300
Accuracy (%)	-25.74	1.99	-25.50	1.99
EPA Standard (%)	NA	NA	NA	< 30-35

MEAN ERROR AT ALL STATIONS

	Calculated	EPA Standard	Equation No.
At All Hours (ts-paired) (ppm)	1.73	NA	(9)
At All Hours (ts-paired) (%)	22.00	NA	(10)
At Peak Hour (s-paired) (%)	19.22	NA	(11)
At Peak Hour (ts-paired) (%)	19.53	< 25-30	(12)
Time Displacement of Peak (hr)	1.00	< 2 hrs	

MEAN BIAS AT ALL STATIONS

	Calculated	EPA Standard	Equation No.
At All Hours (ts-paired) (ppm)	-1.25	NA	(5)
At All Hours (ts-paired) (%)	-15.00	NA	(6)
At Peak Hour (s-paired) (%)	-10.89	NA	(7)
At Peak Hour (ts-paired) (%)	-13.46	NA	(8)

Table VI-3(b). Summary of performance evaluation statistics for combined modeling results of UAM and CAL3QHC for eight-hour averages.

Observed max = 10.50 at WISR on Julian day 97351 hour 0300

cut off = 5. ppm

	Accuracy of Peak Estimates (%)			
	Paired	T-Paired	S-Paired	Unpaired
Equation No.	(1)	(2)	(3)	(4)
Conc (ppm)	8.74	10.71	8.74	10.71
X-cell	11	15	11	15
y-cell	15	13	15	13
Date	94351	94351	94351	94351
Hour	0300	0300	0300	0300
Accuracy (%)	-16.80	1.99	-16.80	1.99
EPA Standard (%)	NA	NA	NA	< 30-35

MEAN ERROR AT ALL STATIONS

	Calculated	EPA Standard	Equation No.
At All Hours (ts-paired) (ppm)	1.43	NA	(9)
At All Hours (ts-paired) (%)	18.00	NA	(10)
At Peak Hour (s-paired) (%)	17.12	NA	(11)
At Peak Hour (ts-paired) (%)	17.01	< 25-30	(12)
Time Displacement of Peak (hr)	0.75	< 2 hrs	

MEAN BIAS AT ALL STATIONS

	Calculated	EPA Standard	Equation No.
At All Hours (ts-paired) (ppm)	-0.93	NA	(5)
At All Hours (ts-paired) (%)	-10.00	NA	(6)
At Peak Hour (s-paired) (%)	-8.79	NA	(7)
At Peak Hour (ts-paired) (%)	-10.93	NA	(8)

VI-1-3. SUMMARY OF MODEL PERFORMANCE

The following statistical performance measures were required by the EPA Guideline [21]:

(A) unpaired (time or space) peak eight-hour prediction accuracy (equation (4)) within the range of ± 30~35 percent,

(B) paired (time and space) mean absolute error in eight-hour peak prediction accuracy values greater than 5.0 ppm (equation (12)) less than 25~30 percent, and

(C) paired (space only) mean absolute error in the predicted time of the eight-hour peak concentration value greater than 5.0 ppm less than two hours.

The performance of the UAM modeling alone without the microscale components compared to the EPA criteria is summarized below.

Statistical Measure	EPA Acceptable Range	Simulated Without Microscale Contribution
(A)	± 30~35 %	1.99 %
(B)	< 25~30 %	19.53 %
(C)	< 2 hours	1.00 hrs.

The performance of UAM plus CAL3QHC compared to the EPA criteria is summarized below.

Statistical Measure	EPA Acceptable Range	Simulated
(A)	± 30~35 %	1.99 %
(B)	< 25~30 %	17.01 %
(C)	< 2 hours	0.75 hrs.

As shown, the three statistical measures remain within EPA acceptable ranges with or without the microscale component included.

In summary, UAM model performance for the December 16-17, 1994 episode is satisfactory and acceptable by EPA standards, whether or not the microscale component is included. The graphical analysis component of the model performance evaluation indicates that, in general, the temporal and spatial characteristics of the observed carbon monoxide concentration patterns are replicated for the episode. The simulated eight-hour peak concentration is higher than the monitored eight-hour peak concentration by 1.99 percent.

In the previous MAG Serious Area CO Plan which utilized MOBILE5a for estimating onroad mobile emissions, the peak UAM estimated CO concentration at the West Phoenix (WPHX) monitoring site on December 17 was 6.27 ppm or 37.31% underpredicted. The maximum observed CO at WPHX on December 17 was 10 ppm. By employing the EPA MOBILE6 model for estimating onroad mobile emissions in the current study, the modeling performance at the WPHX monitoring site has been improved, although is still underpredicted. The peak UAM estimated CO concentration at the West Phoenix (WPHX) monitoring site on December 17 is 6.76 ppm or 32.41% underpredicted in the present study. One possible explanation for this underprediction is potentially older vehicle fleet in the area. The M6Link emissions model assumes that vehicle age distributions are consistent across the modeling area.

The paired mean absolute error, unpaired accuracy of the peak concentration, and the time displacement of the peak for the episode are within the EPA-recommended ranges. In addition to the three statistical measures recommended by EPA, the other statistics presented in Tables VI-3(a) and (b) also indicate that the model predictions agree well with observations. It can be concluded that the overall model performance is satisfactory and that the UAM simulations for the December 16-17, 1994 episode is satisfactory and within EPA standards.

SECTION VII. MAINTENANCE DEMONSTRATION

The Clean Air Act requires that a request for redassification include not only an absence of monitored violations (no violations of the CO standard have occurred at any monitor in Maricopa County since 1996) and an approved attainment demonstration, but also an approvable maintenance plan. The maintenance demonstration documented in this section reflects the continued efforts within the area to improve air quality through the year 2015.

The committed maintenance measures described in this section were evaluated in combination to determine their impact on reducing CO concentrations in the maintenance year. The modeling analyses described in this section provide a quantitative evaluation of maintenance of the 8-hour average CO NAAQS, which is 9 parts per million (ppm), in the maintenance year.

VII-1. Identification of Future Years

The primary purpose of conducting areawide modeling is to demonstrate control strategy effectiveness in maintaining the 8-hour CO NAAQS for at least ten years after the Maricopa County Nonattainment area has been redesignated to attainment status. In determining the amount of lead time to allow, EPA indicated that 18 months, as granted in section 107(d)(3)(D) of CAAA, should be assumed for EPA to approve a redesignation request [1]. Due to uncertainties regarding the time that the area will be redesignated to attainment, year 2015 was modeled to assure that the 8-hour CO NAAQS is maintained at least ten years past an official notice of redesignation to attainment by EPA.

In addition to 2015, a second year of 2006 was modeled and included in the maintenance plan in order to provide a 2006 mobile source emissions budget for conformity purposes.

The simulations for 2006 and 2015 were conducted with UAM and the intersection model CAL3QHC. The combined results from the UAM and CAL3QHC modeling were used to determine whether the Maricopa County area will show maintenance of the federal standard for carbon monoxide with committed control measures. After the UAM base case was prepared, evaluated, and judged acceptable for future-year assessments, projected 2006 and 2015 emissions were modeled to establish future year conditions under episodic meteorological conditions that are likely to recur in the future.

VII-2. Committed Control Measures

Generally, the overall approach taken in preparing the Maintenance Plan is to demonstrate maintenance of the carbon monoxide standard in 2006 and 2015 with the committed measures in the Revised MAG 1999 Serious Area Carbon Monoxide Plan. Therefore, the Maintenance Plan relies heavily upon the Revised MAG 1999 Serious Area Carbon Monoxide Plan and its supporting documents including the commitments to implement control measures.

The committed control measures included in this analysis are the same measures included in the Revised CO Plan [11]. However, two committed contingency measures in the Revised CO Plan have become committed maintenance measures in the maintenance plan. In addition, although not quantified in the Revised CO Plan, Off Road Vehicle and Engine Standards is a maintenance measure for which emission reduction credit has been taken in the maintenance plan. Two measures in the Revised CO Plan, Voluntary Lawn Mower Emission Reduction Program and Catalytic Converter Replacement Program, are not included in the maintenance plan, because of uncertainty in the continued funding for the programs. In addition, the National LEV program included in the Revised CO Plan as a contingency measure is no longer a control measure in the maintenance plan. This is because the maintenance plan modeling effort incorporates vehicle emission factors from the EPA MOBILE6 model, which includes the effects of the National LEV program by default. In the case of the Revised CO Plan, MOBILE5a was utilized. Since MOBILE5a did not include the National LEV program by default, the benefits of the program were included as a contingency measure in that plan.

Descriptions of the committed control measures in the maintenance plan are organized in three groups below. The first group of measures (in Section VII-2-1) includes those for which numeric credit is assumed in the maintenance demonstration. The combined emission reduction impact of this class of measures, described as maintenance measures, is reflected in the 2006 and 2015 modeling inventories described in Section VII-3. Two contingency measures and one measure not quantified in the Revised CO Plan are included in this first group of maintenance measures. The modeling methodologies for the measures in this group are summarized later in this section, with more detailed descriptions provided in Appendix VII.

The second group of measures (in Section VII-2-2) includes the committed measures that are part of the contingency plan described in Section VII-5. For these measures, a benefit is quantifiable, but no credit was taken in the maintenance demonstration. The impact of these measures is not reflected in the 2006 nor 2015 modeling inventories in Section VII-3.

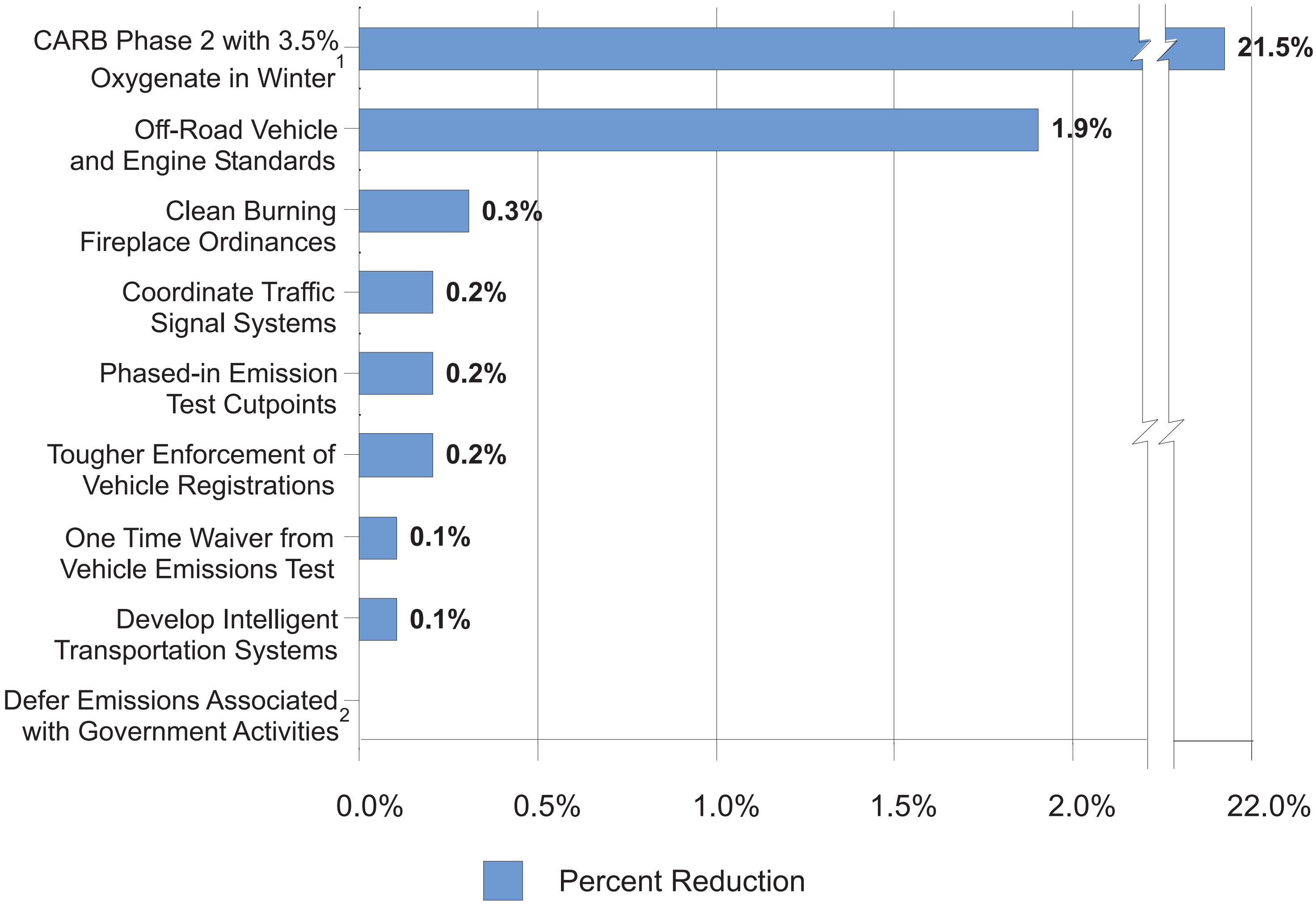
A summary of the committed maintenance and contingency measures taken for numeric credit is provided in Table VII-1. For comparison purposes, Table VII-1 also indicates the status of these measures in the Revised CO Plan [11] (i.e., whether they were attainment, contingency, or not-quantified measures).

The general approaches used to model the emission reductions from the individual measures are similar to those used in the Revised CO Plan [11]. Figure VII-1 illustrates the emission reduction impact of the individual maintenance measures in 2015. Table VII-2 quantifies the emission reductions from the committed maintenance measures in metric tons per day. Figure VII-2 illustrates the emission reduction impact of the individual

Table VII-1. Committed measures used for numeric credit in the CO Maintenance Plan.

Measures Used for Numeric Credit in the CO Maintenance Plan	Status in the CO Maintenance Plan	Status in the Revised Serious Area CO Plan
1. CARB Phase 2 with 3.5% Oxygenate in Winter	Maintenance Measure	Attainment Measure
2. Phased-In Emission Test Cutpoints	Maintenance Measure	Attainment Measure
3. One-time Waiver from Vehicle Emissions Test	Maintenance Measure	Attainment Measure
4. Defer Emissions Associated with Government Activities	Maintenance Measure (affects timing rather than magnitude of emissions)	Attainment Measure
5. Coordinate Traffic Signal Systems	Maintenance Measure	Attainment Measure
6. Develop Intelligent Transportation Systems	Maintenance Measure	Attainment Measure
7. Tougher Enforcement of Vehicle Registration and Emission Test Compliance	Maintenance Measure	Contingency Measure
8. Catalytic Converter Replacement Program	Removed Due to Uncertain Funding for Future Years	Contingency Measure
9. Clean Burning Fireplace Ordinances	Maintenance Measure	Contingency Measure
10. Off-Road Vehicle and Engine Standards	Maintenance Measure	Not-Quantified Measure
11. National Low Emission Vehicle Program	Assumed in MOBILE6 by Default	Contingency Measure
12. Expansion of Area A Boundaries	Contingency Measure	Contingency Measure
13. Gross Emitter Waivers Provision	Contingency Measure	Contingency Measure
14. Increase Waiver Repair Limit	Contingency Measure	Contingency Measure
15. Lawn Mower Reduction Program	Removed Due to Uncertain Funding for Future Years	Contingency Measure

FIGURE VII-1
2015 CARBON MONOXIDE EMISSION REDUCTIONS FROM INDIVIDUAL MAINTENANCE MEASURES
(Percent Reduction in Total Emissions)



[1] Of the 21.5 percent reduction in emissions, the majority (21.1 percent) is due to the low sulfur content of the fuel.

[2] This measure influences when emissions occur rather than their magnitude.

NOTE: Individual impact of measures are not additive.

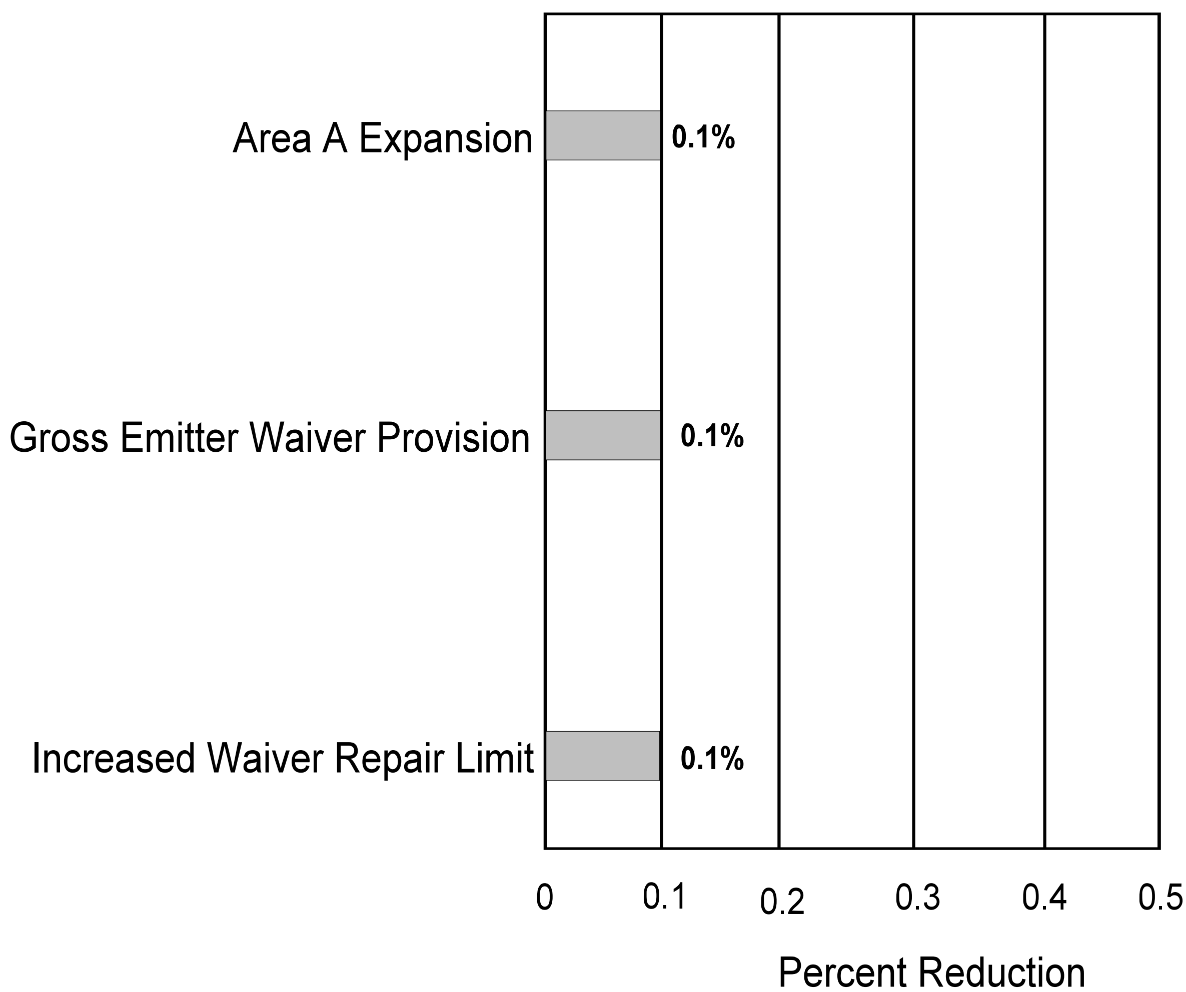
Table VII-2. Summary of 2015 emission reductions from committed maintenance measures used for numeric credit.

Maintenance Measure	Emission Reductions (metric tons/day)	Percent Reduction in Emissions
2015 Emissions Without Maintenance Measures (metric tons/day)	1253.5	
CARB Phase 2 with 3.5% Oxygenate in Winter[1]	269.7	21.52%
Off-Road Vehicle and Engine Standards	24.18	1.93%
Clean Burning Fireplace Ordinances	3.82	0.30%
Coordinate Traffic Signal Systems	2.98	0.24%
Phased-in Emission Test Cutpoints	2.92	0.23%
Tougher Enforcement of Vehicle Registrations	2.25	0.18%
One-time Waiver from Vehicle Emissions Test	1.51	0.12%
Develop Intelligent Transportation Systems	0.89	0.07%
Defer Emissions Associated with Government Activities[2]	0.0	0.00%

[1]Of the 21.5 percent reduction in emissions, the majority (21.1 percent) is due to the low sulfur content of the fuel.

[2]Affects timing rather than magnitude of emissions.

FIGURE VII-2
CARBON MONOXIDE EMISSION REDUCTIONS FROM INDIVIDUAL CONTINGENCY MEASURES IN 2000
(Percent Reduction in Total Emissions)



contingency measures in 2000. The emission reductions are shown for the year 2000, because contingency measures can be triggered in accordance with the provisions of the Contingency Plan anytime after 2000.

The third group of measures (in Section VII-2-3) includes additional measures for which commitments were received in the Revised CO Plan, but numeric emission reduction credit was not taken. The impacts of these measures are not readily quantifiable. However, these measures represent additional legally-enforceable commitments to reduce emissions and improve air quality in the region.

VII-2-1. MEASURES USED FOR NUMERIC CREDIT

The following committed measures were assumed in modeling maintenance of the eight-hour CO standard through 2015. Figure VII-1 identifies the emission reduction credit for each of the individual maintenance measures in 2015. Two of the maintenance measures described below were formerly contingency measures in the Revised CO Plan [11]. These include Tougher Enforcement of Vehicle Registration and Emission Test Compliance and Clean Burning Fireplace Ordinances. Table VII-1 summarizes the maintenance measures and identifies their comparable status in the Revised CO Plan. The descriptions of the modeling methodologies in this section generally reflect a 2015 modeling scenario. The 2006 modeling methodologies are the same unless otherwise noted.

Descriptions of Individual Maintenance Measures

1. Winter Fuel Reformulation: California Phase 2 Reformulated Gasoline with 3.5 Percent Oxygen Content November 1 Through March 31

   Arizona Legislature passed H.B. 2347 in 1998 which contains requirements for all gasoline produced and shipped to Maricopa County and sold or offered for sale for use in motor vehicles in Area A from and after November 1, 2000 through March 31, 2001 and from the period beginning November 1 through March 31 of each subsequent year. The fuel must comply with the standards for California Phase 2 Reformulated Gasoline, including alternative reformulations allowed by the predictive model, as adopted by the California Air Resources Board, and must meet the maximum vapor pressure requirements of 9 pounds per square inch in A.R.S. 41-2083, Subsections D and F. The fuel must also contain a minimum oxygen content by weight of 3.5 percent as required in A.R.S. 41-2123, Subsection A, Paragraph 2.

   From November 1, 2000 through March 31, 2001 and each winter season of November through March thereafter, the Director of the Arizona Department of Weights and Measures is required to determine the average levels of the constituents in the gasoline sold or offered for sale in Area A. The Director of the Arizona Department of Environmental Quality must analyze the data and no later than July 1, 2001 and each July thereafter, determine the average daily carbon monoxide reductions resulting from the use of the gasoline during the preceding winter season. If the average daily carbon monoxide reductions resulting from the gasoline are less than 90 percent of the goal of 32 tons per day in 2001, 31 tons per day in 2003 and 30 tons per day in 2005, 29 tons per day in 2007, or 28 tons per day in 2009, the Arizona Department of Environmental Quality will immediately notify the Governor, President of the Senate, and Speaker of the Arizona House of Representatives.

Also, any registered supplier or oxygenate blender may petition the Director of the Department of Weights and Measures to authorize the use of other oxygenates if an ethanol shortage is imminent. A petition must: (a) Identify specific supply conditions that will result in a shortage of ethanol. (b) Identify which oxygenate or oxygenates will be blended into gasoline for sale or use in Area A. (c) Demonstrate that the alternative oxygenate blend comes closest to meeting a 3.5 percent by weight oxygen content at reasonable cost. (d) Specify a time period for compliance with any provision of A.R.S. 41-2123, Subsection A, not to exceed 60 days.

The Director of Weights and Measures will either grant or deny the petition within seven days of its receipt. The decision to grant a waiver will be equally equitable to all registered suppliers or oxygenate blenders. The petition may be reauthorized for up to 30 days if the shortage conditions continue. The Director of the Arizona Department of Weights and Measures is required to consult with the Director of the Arizona Department of Environmental Quality prior to granting, reauthorizing or denying any petition.

The legislation specifies the intent of the Legislature to re-evaluate the existing authorized measures as well as alternative measures if this winter gasoline reformulation does not result in the carbon monoxide emission benefits specified in the bill (A.R.S. 41-2124).

Modeling Methodology

A January 30, 1998 Draft report from MathPro titled Evaluation of Gasoline and Diesel Fuel Options for Maricopa County suggests an average future gasoline formulation which is likely to be present in Area A with the passage of a law requiring California Phase 2 gasoline. The impact of this alternative gasoline formulation was modeled in two stages for the Revised CO Plan [11]. In the first stage, MOBILE5a was used to estimate the impact of the RVP and oxygenate content and market share. In the second stage, the CO COMPLEX Model was used to estimate the impact of changes to other fuel properties (e.g. sulfur and olefins). The CO COMPLEX model, although not an official model of the EPA, provides an estimate of the benefits of different fuel formulations on CO emissions from gasoline-powered onroad vehicles. No other model is available which estimates the effects of as wide of a range of fuel properties on carbon monoxide emissions as does the CO COMPLEX model.

In this analysis, all onroad credit for the committed measure package gasoline is applied using the MOBILE6 model. The MOBILE6 model considers the gasoline RVP value, the sulfur content levels, and oxygenate content and market share. Consistent with the Revised CO Plan, a market share of 100 percent ethanol was assumed. The CO COMPLEX model was not used to estimate the impact of the fuel on onroad vehicles because the CO COMPLEX model is based on vehicles with 1990 model year technology and therefore may not accurately reflect the impact of fuel changes on the vehicle fleet in 2006 or 2015. The methodology used to estimate the CO benefit for nonroad source categories is described below.

The impact of this measure on nonroad emissions was modeled by emissions post-processing. The difference between CO emissions from the MathPro formulation and a baseline fuel representative of wintertime fuel characteristics in the Maricopa County area (with the exception of enhanced oxygenate content) was estimated with the CO COMPLEX model in the Revised CO Plan. This credit was applied by Maricopa County in the 1999 periodic inventory used as a base in this analysis. The credit for the enhanced oxygenate content of the fuel was calculated using the EPA MOBILE5a model looking at old technology vehicles. The estimated fractional benefit of the enhanced oxygenate content calculated using MOBILE5a was applied to the base case emissions from nonroad gasoline powered vehicles using the EPS2.0 CNTLEM module.

This measure was an attainment measure in the Revised CO Plan. The emission reduction credit attributable to this measure in the 2000 attainment demonstration was 6.8%. The emission reduction credit attributable to this maintenance measure in 2015 is 21.52%, the majority of which (about 21.1%) is due to the low sulfur content of the fuel.

2. <u>Phased-In Emission Test Cutpoints</u>

Arizona Legislature passed H.B. 2237 in 1997 which contains an appropriation of $120,000 from the State General Fund to the Arizona Department of Environmental Quality to develop and implement an alternative test protocol to reduce the false failure rates associated with the more stringent pass-fail standards for the Vehicle Emissions Testing Program (Section 19 of H.B. 2237).

In 1998, the Arizona Legislature passed S.B. 1427 which requires that vehicles in Area A and B be emissions tested. The vehicles subject to the Vehicle Emissions Inspection Program that have been included within the new boundaries of Area A are required to comply beginning from and after December 31, 1998. The newest five model year vehicles are exempted from the Vehicle Emissions Inspection

Program on a rolling basis. Owners of these vehicles are required to pay an in lieu fee equivalent to the price of the test unless they choose to take and pay for an emissions test. The in lieu fees will be deposited into the Arizona Clean Air Fund. S.B. 1427 also allows the Vehicle Emissions Inspection contract to be extended for three additional years (A.R.S. 49-542, 49-543, 49-545 and Section 41 of S.B. 1427).

In addition, the Arizona Department of Environmental Quality will be implementing Interim Test Cutpoints for the Vehicle Emissions Inspection Program until issues are resolved with the final test cutpoints for the I/M 240 Program. The Interim Cutpoints were selected in an attempt to achieve the following failure rates in all three vehicle class categories (Light Duty Gasoline Vehicles, Light Duty Gasoline Trucks 1, and Light Duty Gasoline Trucks 2: 50 percent for Model Years 1981 to 85; 25 percent for 1986 to 1989 model years, and 10 percent for Model Years 1990 to 93).

Modeling Methodology

The alternative protocol is anticipated to consist of a change from the previous I/M 240 test to a test consisting of dual phase 2 tests where phase two is the second phase of the traditional I/M 240 test.

This measure was modeled by modification of MOBILE6 input files. With the implementation of this measure, vehicles which are subject to the enhanced I/M program are held to a stricter set of cutpoints than would otherwise be the case. The stricter cutpoints were implemented in January 2000. If a vehicle exceeds the emissions of the cutpoint set for carbon monoxide, hydrocarbons, or NOx, the vehicle fails the test.

For the analysis of a 2006 or 2015 scenario, model years 1980 and older are assumed to be subject to a basic I/M test and model years 1996 and newer are expected to be subject to an on-board diagnostic test. For these reasons, it is assumed that the only model years affected by the phased-in cutpoints will be model years 1981 through 1995, when looking at the future year scenarios.

The base case cutpoints input to the MOBILE6 model, as used in the I/M240 program, were based upon Appendix A of the Sierra Research report [29]. The committed maintenance measure cutpoints input to the MOBILE6 model were derived from data provided by the Arizona Department of Environmental Quality.

The benefits of the measure were estimated by rerunning MOBILE6 and M6Link using data provided in an ADEQ memo that reflects the enhanced cutpoints. The enhanced cutpoints were input to the MOBILE6 model as used in the I/M147 program.

This measure was an attainment measure in the Revised CO Plan. The emission reduction credit attributable to this measure in the 2000 attainment demonstration was 2.7%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.23%.

3. <u>One-Time Waiver from Vehicle Emissions Test</u>

Arizona Legislature passed S.B. 1002 in 1996 which limits the issuance of a waiver for failure to comply with the emission testing requirements to one-time only beginning January 1, 1997.

Also, the Arizona Legislature passed House Bill 2237 in 1997 which requires the Arizona Department of Environmental Quality to submit a report on one-time vehicle waivers to the Governor, President of the Senate, and Speaker of the House of Representatives by September 30, 1997. The report is required to include: a description of the air quality benefits from the measure; recommendations on making the provision more effective, considering the impact on motorists; and recommendations on improving motorists access to the repair grant program.

<u>Modeling Methodology</u>

This measure was modeled by the modification of MOBILE6 input files. MOBILE6 does not have the option of limiting the number of waivers to a given number of years. However, MOBILE6 does have the option of changing the percentage of vehicles receiving waivers. MOBILE6 was run with an adjusted waiver percentage allowed in order to estimate the resulting decrease in carbon monoxide emission rates in 2015.

It is assumed that the average remaining vehicle life of a vehicle which has received a waiver is three years as estimated on page E-5 a 1993 Sierra Research report [30]. It is assumed that the base case run includes the three-year life after waiver implicitly through MOBILE6. This measure would effectively reduce that three-year life to one year, and result in approximately two thirds of the reductions of a change to zero waivers. The waiver rate, which was four percent for pre-81 model years and three percent for 1981 and later model years, was changed to one and one third percent and one percent, respectively.

This measure was an attainment measure in the Revised CO Plan. The emission reduction credit attributable to this measure in the 2000 attainment demonstration was 0.3%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.12%.

4. <u>Defer Emissions Associated with Government Activities</u>

A number of jurisdictions have identified their intent to pursue methods for deferring emissions out of critical air pollution periods. These activities include restructuring use of two-cycle gasoline-powered lawn and garden maintenance equipment after 2:00 p.m., placing requirements on maintenance contractors, and encouraging employees to limit vehicle idling and other activities which may contribute to air pollution during critical periods.

Modeling Methodology

Based on commitments received, it is estimated that approximately six percent of two-stroke engine powered nonroad emissions occurring after 2:00 p.m. are shifted to between 6:00 a.m. and 2:00 p.m. This measure was modeled in the TMPRL module of EPS2.0. The TMPRL module is capable of allocating emissions to certain hours of the day.

It is assumed that this measure will result in a reduction in the use of two-stroke gasoline engine equipment by governmental agencies in the afternoon during the winter CO season. It is further assumed that six percent of the total affected emissions occurring after 2:00 p.m. are shifted to between 6:00 a.m. and 2:00 p.m.

Based on these assumptions, the temporal profile for two-stroke gasoline powered equipment was adjusted to reflect a decrease in emissions after 2 p.m. by six percent. These emissions were reallocated to between 6:00 a.m. and 2:00 p.m.

This measure was an attainment measure in the Revised CO Plan. No emission reduction credit was quantified for this measure in the 2000 attainment demonstration or 2015 maintenance demonstration, because the measure influences when emissions occur, rather than their magnitude.

5. Coordinate Traffic Signal Systems

House Bill 2237 contains an appropriation of $500,000 in each of fiscal years 1997-1998 and 1998-1999 from the state general fund to the Arizona Department of Transportation for distribution to cities and counties for synchronization of traffic control signals within and across jurisdictional boundaries (Section 23 of H.B. 2237).

In addition, cities and towns responded to measure 97-TC-8, Coordinate Traffic Signal Systems. The synchronization of existing signals, as well as the enhancement of coordination in signal systems which are already synchronized, has been identified by many jurisdictions through a number of programs. Enhancement efforts range from large scale programs covering broad geographic areas to incremental additions of a few synchronized signals to the network. This includes both individual city projects and regional level programs, such as AZ Tech which is noted under Develop Intelligent Transportation Systems below.

Modeling Methodology

Based on submittals from local governments, as well as the provision in H.B. 2237 for signal coordination, it is estimated that the coordination will be enhanced for approximately 661 signals in the region. This estimate is based upon both the commitments made by the jurisdictions and also the results of an analysis performed with GIS software.

This measure was modeled by modification of MOBILE6 input files and by emissions post-processing. The enhancement of traffic signal synchronization will reduce the idling time at traffic signals. The average CO emission rate at idle was estimated with the MOBILE6 model. The emission rate at idle was multiplied by the estimated reduction in idle time across the modeling domain due to the control measure. The resulting product was a total reduction in CO emissions in the modeling domain. This emission reduction was applied as an across-the-board reduction to the onroad CO emissions inventory.

This measure was an attainment measure in the Revised CO Plan. The emission reduction credit attributable to this attainment measure in the 2000 attainment demonstration was 0.6%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.24%.

6. Develop Intelligent Transportation Systems

Nearly all the local jurisdictions have begun planning and implementing advanced technology based solutions to address complex traffic management issues on the regional transportation network. These technologies involve the application of electronics, telecommunications and sensor technologies and are collectively referred to as Intelligent Transportation Systems.

A key component of the regional Intelligent Transportation Infrastructure is the Freeway Management System (FMS) operated by Arizona Department of Transportation (ADOT). The FMS currently covers 42 miles of the freeway system and provides services such as traveler advisories and incident management. The other major regional ITS initiative is the AZTech project. This project was selected and funded by USDOT to serve as one of four ITS Model Deployment Initiatives in the nation. Key elements of the AZTech project are the interconnection of 13 local traffic management centers and the instrumentation of eight “smart” corridors that cover nearly 150 miles or arterial streets.

More than 90 city buses have been equipped with Global Positioning Satellite receivers to report their location. Electronic kiosks have been installed at more than 20 locations.

Modeling Methodology

This measure was modeled by modification of MOBILE6 input files and by emissions post-processing. The emission reductions from the three components of this measure, FMS, the installation of ITS instrumentation from AZTech, and enhancing of signal coordination were modeled separately.

The emissions benefit of the continued installation of the FMS was estimated using the modeling methodology developed by Sierra Research in Feasibility and Cost Effectiveness of New Air Pollution Control Measures Pertaining to Mobile Sources (June 1993). A reduction in emissions per mile of FMS installed was multiplied by the number of additional miles of FMS installed, resulting in a total emission reduction. It was estimated that an additional 33 centerline miles will be implemented by 2000. Given that additional centerline miles are expected to be implemented after 2000, this estimate is likely to be conservative for 2006 or 2015.

The installation of ITS instrumentation from AZTech on 150 miles of arterials will result in an increase in average vehicle speeds due to the rerouting of traffic around congestion. The increase in vehicle speeds and average trip length were estimated in the November 15, 1996 Alternative Transportation System Task Force report.

The change in average vehicle emission rates due to the increase in vehicle speeds was estimated with MOBILE6. The change in emission rates was multiplied by the estimated volume of traffic affected by the control measure, also estimated in the Alternative Transportation System Task Force report. The resulting product estimates the change in emissions due to the speed change. This change was added to the change in total emissions estimated for increase in average trip length. The resulting sum is a total change in CO emissions in the modeling domain due to the control measure.

The enhancing of traffic signal coordination through AZTech was modeled by modification of MOBILE6 input files and by emissions post-processing. The enhancement of traffic signal synchronization will reduce the idling time at traffic signals. The average CO emission rate at idle was estimated with the MOBILE6 model. The emission rate at idle was multiplied by the estimated reduction in idle time across the modeling domain due to the control measure. It is estimated that approximately 95 signals will be affected. The resulting product is a total reduction in CO emissions in the modeling domain.

The three emission reductions modeled from the separate aspects of this measure were totaled. The total was applied as an across-the-board reduction to the onroad CO emissions inventory.

This measure was an attainment measure in the Revised CO Plan. The emission reduction credit attributable to this attainment measure in the 2000 attainment demonstration was 0.4%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.07%.

7. Tougher Enforcement of Vehicle Registration and Emission Test Compliance

Arizona Department of Transportation indicates that this measure would use additional methods to increase the registration compliance of residents. According to the December 1996 Report of the Governor's Air Quality Strategies Task Force, the Motor Vehicle Division (MVD) of the Arizona Department of Transportation (ADOT) has instituted a comprehensive enforcement program. Three key elements of the new program are a Registration Enforcement Team, a Registration Enforcement Tracking System, and a New Resident Tracking Program. Through public participation, consistent policy and procedure application, and new tracking methods, MVD will enforce the Arizona registration laws to ensure vehicles in question are registered properly. This will be an ongoing effort.

Another phase of the Program is an initiative to coordinate ADOT efforts with other law enforcement agencies to assist MVD personnel in enforcing registration compliance. Other initiatives include a system user agreement between MVD and the City Courts to utilize information in conjunction with registration compliance and discussions with U.S. West for obtaining information relating to new connect customers.

The Registration Compliance Program began in January 1994 with one full time employee responding only to complaints. In April of 1996, this program was enhanced with five MVD officers periodically conducting a statewide effort locating and issuing warning notices on vehicles suspected of being in violation of Arizona registration laws. This effort resulted in a substantial increase in Vehicle Licenses Tax (VLT) for 1996. As the program continues, there will be an enhanced focus on the local vehicles not in compliance.

Administration of the program began with a required staff time equivalent to one full time employee. Currently, the required staff time is equivalent to eight full time employees. Additional staff requirements for the initial phase of the Registration Compliance Program will require a total of 12 full time (active) employees and one supervisor. The funding allocated for implementation of the Registration Compliance Program is included as part of the overall MVD budget.

Arizona Legislature passed S.B. 1427 in 1998 which requires school districts and special districts in Area A to prohibit parking in employee parking lots by employees who have not complied with emissions testing requirements. Cities, towns, and counties in Area A and Area B are currently subject to this provision (A.R.S. 49-

552).

In 1999, the Arizona Legislature passed H.B. 2254 which requires each vehicle that is owned by the United States government and that is domiciled in this state for more than ninety consecutive days and each vehicle that is owned by a state or political subdivision of this state to comply with A.R.S. 49-542.

Collectively, the provisions in H.B. 2254 that apply to Tougher Enforcement of Vehicle Registration and Emissions Test Compliance include A.R.S. 49-557 and 49-541.01 D. and E.

Modeling Methodology

This measure was modeled for CO by an adjustment of the weighting between I/M and non-I/M emission factors from MOBILE6. Consistent with the Revised CO Plan, the number of vehicles which participate in the I/M program was increased by 2.0 percent, changing the weighting from 89.6/10.4 to 91.6/8.4. It was assumed that the increased compliance rate will carry forward to future years through continued enforcement. The weighting of I/M versus non-I/M vehicles is applied as an input to the M6Link program.

This measure was a contingency measure in the Revised CO Plan. The emission reduction credit attributable to this contingency measure in the 2000 attainment demonstration was 0.4%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.18%.

8. Clean Burning Fireplace Ordinances

Arizona Legislature passed S.B. 1427 in 1998 which requires cities, towns, and counties in Area A to adopt, implement and enforce an ordinance that complies with the clean burning fireplace standards adopted by the Metropolitan Planning Organization that is responsible for air quality planning in Area A by December 31, 1998. The ordinance must prohibit the installation or construction of a fireplace or wood stove unless it is one of the following:

1. A fireplace that has a permanently installed gas or electric log insert.

2. A fireplace, a wood stove or any other solid fuel burning appliance that is any of the following:

   (a) Certified by the U.S. Environmental Protection Agency as in compliance with 40 Code of Federal Regulations Part 60, Subpart AAA in effect on July 1, 1990.

   (b) A wood stove tested and listed by a nationally recognized testing agency to meet performance standards equivalent to those in 40

Code of Federal Regulations Part 60, Subpart AAA in effect on July 1, 1990.

(c) Determined by the County Air Quality Control Officer to meet performance standards equivalent to those in 40 Code of Federal Regulations Part 60, Subpart AAA in effect on July 1, 1990.

3. A fireplace that has a permanently installed wood stove insert that complies with paragraph 2, subdivision (a), (b) or (c) of this section.

The ordinance is required to prohibit the subsequent conversion or alteration of a permitted fireplace or wood stove to a nonpermitted use. The ordinance may provide for exemptions from regulation for heating or industrial equipment, cooking devices and outdoor fireplaces. The state income tax subtraction of $500 dollars for the purchase and installation of a qualified wood stove, wood fireplace or gas fired fireplace and non-optional equipment is removed. The subtraction of $500 dollars for the conversion of an existing wood fireplace to a qualified fireplace is retained.

A county that contains any portion of Area A that has a population of less than 1,200,000 according to the most recent U.S. decennial census shall adopt, implement, and enforce the ordinance only in those portions of the county which are located in Area A (A.R.S. 9-500.16 and 11-875).

<u>Modeling Methodology</u>

This measure was modeled in the CNTLEM module of EPS 2.0. The CNTLEM module is capable of applying a reduction factor to emissions by ASC.

It is assumed that this measure was implemented in 1999. It is further assumed that all newly constructed residential fireplaces and all newly installed residential wood stoves will be "low-emitters" or EPA-certified Phase II or equivalent. Based on the 1996 MAG Residential Wood Combustion Survey, 28 percent of residences have fireplaces and one percent have wood stoves. Fireplace and wood stove population estimates were derived by combining the aforementioned percentages with the estimated number of residences in the CO Nonattainment Area. These 1994 population estimates were projected to the years 1998, 2006, and 2015 to determine the number of new fireplaces and wood stoves constructed after 1999. All fireplaces constructed in this period were assumed to be EPA certified fireplaces that emit at a rate 49 percent the rate of non-Phase II fireplaces. All wood stoves installed after 1999 were assumed to be EPA-certified Phase II or equivalent stoves that emit at 77 percent (CO) the rate of the emission rate of the AP-42 category "all stoves". Based on these assumptions, it is estimated that fireplace emissions will be 16.0 percent lower in 2015 than they would have been without this measure. Wood stove emissions will be 6.9 percent lower in 2015 than they would have been without this measure.

For the 2015 analysis, a /PROJECT AMS/ packet applied factors of 0.840 to fireplaces (ASC 2104008001) for CO, and 0.931 to wood stoves (ASC 2104008010). The newly created packet was applied by an additional execution of the CNTLEM module after the area source emissions had been projected to 2015.

This measure was a contingency measure in the Revised CO Plan. The emission reduction credit attributable to this contingency measure in the 2000 attainment demonstration was 0.1%. The emission reduction credit attributable to this maintenance measure in 2015 is 0.3%.

9. Off-Road Vehicle and Engine Standards

Arizona Legislature passed H.B. 2237 in 1997 which requires the Arizona Department of Environmental Quality to adopt rules for air pollution emission standards for off-road vehicles and engines marketed in the State beginning with the 1999 model year. The standards may include the following categories:

a. Heavy duty diesel vehicles rated at 175-750 horsepower.
b. Small utility and lawn and garden equipment engines rated at less than 25 horsepower.
c. Recreational vehicles rated at less than 25 horsepower.
d. Specialty engines and go-carts rated at greater than 25 horsepower.
e. Off-road motorcycles and all terrain vehicles.

The Arizona Department of Environmental Quality is also required to adopt air pollution emission standards for golf cart engines in Maricopa County (A.R.S. 49-542.04).

Since the adoption of H.B. 2237, federal standards for the same class and types of off-road engines and equipment became effective that are either equivalent to or more stringent than California's standards. Consequently, the Arizona Department of Environmental Quality submitted a letter to EPA on September 7, 2001 to inform EPA of ADEQ's intent to withdraw from adopting California's standards for off-road vehicles and engines marketed in the state, beginning with the 1999 model year. Therefore, the federal off-road standards are being implemented in this state.

Modeling Methodology

This measure was modeled in the CNTLEM module of EPS 2.0. The CNTLEM module is capable of applying a reduction factor to emissions by ASC.

It was assumed that this measure will result in the replacement of nonroad equipment engines with engines meeting new EPA phase II nonroad engine standards at a turnover rate of 14 percent per year for spark-ignition (i.e. two and four-stroke gasoline) engines and four percent per year for compression-ignition engines (i.e. diesel). It was assumed that the measure takes effect from 1999 through 2004 for engines affected by this measure.

A /PROJECT AMS/ packet applied control factors to the appropriate nonroad engine types. The newly created packet was applied by an additional execution of the CNTLEM module after the nonroad emissions had been projected to 2006 and 2015.

This measure was a committed control measure in the Revised CO Plan, but was not quantified in that Plan, because the new standards would not be fully in place until 2004. The emission reduction credit attributable to this maintenance measure in 2015 is 1.93%.

VII-2-2. MEASURES INCLUDED IN THE CONTINGENCY PLAN

The following committed control measures are contingency measures in the CO Maintenance Plan. Figure VII-2 identifies the emission reduction credit for each of the individual contingency measures in 2000. The emission reductions are shown for the year 2000, because contingency measures can be triggered in accordance with the provisions of the Contingency Plan anytime after 2000. These three contingency measures have already been implemented in the nonattainment area. Early implementation of contingency measures is allowed by EPA and helps to ensure that the standard will be maintained through 2015. The Contingency Plan in the CO Maintenance Plan discusses procedures that will be followed to consider and implement additional contingency measures, as needed.

It is also important to note that two contingency measures in the Revised CO Plan, Tougher Enforcement of Vehicle Registration and Emission Test Compliance and Clean Burning Fireplace Ordinances, are maintenance measures in the Maintenance Plan. Another contingency measure in the Revised CO Plan, Voluntary Lawn Mower Emission Reduction Program, is not included in the Maintenance Plan, because funding for this program after 2000 is uncertain. Table VII-1 summarizes the maintenance and contingency measures in the Maintenance Plan and identifies their comparable status in the Revised CO Plan.

Descriptions of Individual Contingency Measures

1. Expansion of Area A Boundaries

Arizona Legislature passed S.B. 1427 in 1998 which expands the boundaries of Area A. Previously, the Area A boundaries followed the boundaries of the carbon monoxide and ozone nonattainment areas. Area A was expanded to include additional portions of Maricopa County, portions of Pinal County, and portions of Yavapai County. The Area A boundaries are delineated as follows:

(a) In Maricopa County:
Township 8 North, Range 2 East and Range 3 East
Township 7 North, Range 2 West Through Range 5 East
Township 6 North, Range 2 West Through Range 6 East
Township 5 North, Range 2 West Through Range 7 East
Township 4 North, Range 2 West Through Range 8 East
Township 3 North, Range 2 West Through Range 8 East
Township 2 North, Range 2 West Through Range 8 East
Township 1 North, Range 2 West Through Range 7 East
Township 1 South, Range 2 West Through Range 7 East
Township 2 South, Range 2 West Through Range 7 East

(b) In Pinal County:
Township 1 North, Range 8 East And Range 9 East
Township 1 South, Range 8 East And Range 9 East
Township 2 South, Range 8 East And Range 9 East
Township 3 South, Range 7 East Through Range 9 East

(c) In Yavapai County:
Township 7 North, Range 1 East And Range 1 West Through Range 2 West

All of the air quality measures and programs added or modified by S.B. 1427 for Area A will be effective from and after December 31, 2000 in the portion of Area A which includes Pinal County. This does not apply to the conversions of fleet vehicles to alternative fuels by cities, counties, and school districts. Also, the vehicles subject to the Vehicle Emissions Inspection Program that have been included within the new boundaries of Area A, except those within Pinal County, are required to comply beginning from and after December 31, 1998. Vehicles in the Pinal County area are required to comply beginning from and after January 1, 2001.

Collectively, the air quality measures which apply specifically to Area A are: Traffic Synchronization; Plans to Stabilize Targeted Unpaved Roads, Alleys, and Stabilize Unpaved Shoulders on Targeted Arterials; Crack Seal Equipment; Alternative Fuel Vehicles Requirements for Local Governments and School Districts; Adjusted Work Hours; Clean Burning Fireplace Ordinances; Use of Petroleum Products for Road Maintenance; Winter Fuel Reformulation: California Phase 2 Reformulated Gasoline with 3.5 Percent Oxygen Content by Weight; Stage I and II Vapor Recovery; Voluntary Vehicle Repair and Retrofit Program; Vehicle Emissions Testing Program Requirements (including Vehicle Repair Grant Program); Tougher Enforcement of Vehicle Registration and Emissions Test Compliance; and Travel Reduction Program (A.R.S. 49-541 and Section 41 and 42 of S.B. 1427).

This measure was also a contingency measure in the Revised CO Plan. The emission reduction credit attributable to this contingency measure in the 2000 attainment demonstration was 0.1%. It is important to note that the methodology for quantifying the emission reduction credit for this measure in the Revised CO Plan and this maintenance plan does not take into account the portion of Area A located in Pinal County. Pinal County was excluded from the emission reduction calculation, because Pinal County is located outside of the CO nonattainment area boundaries.

2. Gross Emitter Waivers Option

Arizona Legislature passed S.B. 1427 in 1998 which requires that in order to obtain a waiver from compliance with the Vehicle Emissions Inspection Program, the owner of a vehicle emitting more than twice the emission standard has to repair the vehicle sufficiently to reduce the emission levels to less than twice the standard (A.R.S. 49-542).

This measure was also a contingency measure in the Revised CO Plan. The emission reduction credit attributable to this contingency measure in the 2000 attainment demonstration was 0.1%.

3. Increased Waiver Repair Limit

Arizona Legislature passed S.B. 1427 in 1998 which increases the amount a person must spend to repair a failing 1967-1974 vehicle in Area A to qualify for a waiver. The increased amount is $200 rather than the previous $100 (A.R.S. 49-542).

This measure was also a contingency measure in the Revised CO Plan. The emission reduction credit attributable to this contingency measure in the 2000 attainment demonstration was 0.1%.

VII-2-3. MEASURES WHICH IMPROVE AIR QUALITY, BUT WERE NOT USED FOR NUMERIC CREDIT

The third group represents measures that were not quantified for emission reduction credit, but are committed measures in both the attainment and maintenance plans. Although not quantified in the Revised CO Plan, Off Road Vehicle and Engine Standards, is a maintenance measure for which emission reduction credit has been taken in the maintenance plan.

Descriptions of Individual Measures Not Used for Numeric Credit

1. Vehicle Repair Grant Program

Arizona Legislature passed S.B. 1427 in 1998 which appropriates $275,000 from the State General Fund to the Arizona Department of Environmental Quality for fiscal year 1998-1999 to improve the utilization of the Vehicle Repair Grant Program and to implement the Catalytic Converter Replacement Program. The Vehicle Repair Grant Program also applies to Area A (Section 39 of S.B. 1427).

2. Random Roadside Testing of Diesel Vehicles

Arizona Legislature passed S.B. 1427 in 1998 which requires the Arizona

Department of Environmental Quality to implement a pilot random roadside emissions testing program for diesel vehicles over 8,500 pounds using the snap acceleration test developed by the Society of Automotive Engineers (J 1167). This program will not be implemented unless the Directors of the Arizona Department of Transportation and Arizona Department of Public Safety agree that the program can be conducted safely and in compliance with federal regulations relating to interstate travel and safety.

If the program is implemented by November 15, 1999, the ADEQ Director will report on the results of the pilot program, including pass and fail rates, the nature of the registration of the failing vehicles, the extent of noncompliance of the failing vehicles, and recommendations for implementation of a permanent program. The report will be transmitted to the Governor, Speaker of the House of Representatives, and President of the Senate (Section 35 of S.B. 1427).

3. Snap Acceleration Test for Heavy-Duty Diesel

Arizona Legislature passed S.B. 1002 in 1996 which requires that beginning March 1, 1997, a diesel powered motor vehicle applying for registration or reregistration in Area A more than 33 months after the date of initial registration shall be required to take and pass an annual emissions test conducted at an official emissions inspection station or a fleet emissions inspection station as follows:

- a loaded, transient or any other form of test as provided for in rules adopted by the Director for vehicles with a gross vehicle weight rating of 8,500 pounds or less.

- a test that conforms with the Society of Automotive Engineers Standard J1667 for vehicles with a gross vehicle weight rating of more than 8,500 pounds (A.R.S. 49-542 F.2.(d).).

4. Long - Term Fuel Reformulation: From and After May 1, 1999

Arizona Legislature passed H.B. 2307 in 1997 which contains requirements for the sale of gasoline from and after May 1, 1999 in Area A, subject to an appropriate waiver granted under Section 211 (c)(4) of the Clean Air Act, that meets the following fuel reformulation options:

- California Phase 2 Reformulated Gasoline, including alternative formulations allowed by the predictive model, as adopted by the California Air Resources Board pursuant to the California Code of Regulations, Title 13, Sections 2261 through 2262.7 and 2265, in effect on January 1, 1997, that meets the maximum 7.0 psi summertime vapor pressure requirements in A.R.S. Section 41-2083, Subsections D and F.

- Gasoline that meets the standards for Federal Phase II Reformulated

Gasoline, as provided in 40 CFR Section 80.41, paragraphs (a) through (h), in effect on January 1, 1997, that meets the maximum 7.0 psi summertime vapor pressure requirement in A.R.S. Section 41-2083 Subsections D and F.

- From and after November 1 through March 31 of each year, both of these fuels are required to meet the oxygenated fuel requirements in A.R.S. 41-2123.

By September 15, 1997, the Director of the Arizona Department of Environmental Quality in consultation with the Director of the Weights and Measures, is required to adopt rules for the 1998 and 1999 fuel reformulation requirements.

House Bill 2307 also provides that if the Environmental Protection Agency fails to approve the sale and use of both reformulated gasolines, the Director of the Arizona Department of Environmental Quality will adopt standards by rule for one of the following fuels:

- A gasoline that meets standards for Federal Phase II Reformulated Gasoline, as provided in 40 C.F.R. Section 80.41, paragraphs (a) through (h) in effect on January 1, 1997, that meets the maximum vapor pressure requirements of A.R.S. Section 41-2083, Subsections D and F. In addition, the requirements of A.R.S. Section 41-2123 must be met November 1 through March 31 of each year.

- California Phase 2 Reformulated Gasoline, including alternative formulations allowed by the predictive model, as adopted by the California Air Resources Board pursuant to the California Code of Regulations, Title 13, Sections 2261 through 2262.7 and 2265, in effect on January 1, 1997, that meets the maximum vapor pressure requirements of A.R.S. Section 41-2083, Subsections D and F. In addition, the requirements of A.R.S. Section 41-2123 must be met November 1 through March 31 of each year.

5. <u>Limit Sulfur Content of Diesel Fuel Oil to 500 ppm</u>

Arizona Legislature passed S.B. 1002 in 1996 which prohibits the sale of diesel fuel (including off-road) in the nonattainment area that contains in excess of 500 ppm sulfur. In addition, federal regulations require that on-road diesel fuel sold throughout the contiguous U.S. have a maximum sulfur content of 0.05 percent by weight (500 ppm). These provisions are contained in A.R.S. 41-2083 J.

6. <u>Diesel Fuel Sampling and Reporting</u>

Arizona Legislature passed S.B. 1427 in 1998 which requires that beginning on January 1, 1999 through July 1, 1999, gasoline refiners and other suppliers of diesel fuel that is supplied or sold as a final product for the fueling of diesel vehicles within Area A report to the Director of the Arizona Department of Weights and Measures on the quantity and quality of diesel fuel shipped to Maricopa County during the preceding month. The report is required to include by batch, the sulfur content, aromatic hydrocarbon content, cetane number, specific gravity, American Petroleum Institute gravity, and the temperatures at which ten percent, fifty percent, and ninety percent of the diesel fuel has boiled off during distillation. The report is due on the fifteenth day of each month.

In addition, the report must contain a certification of truthfulness and accuracy of the data submitted. By October 1, 1999, the Director of the Arizona Department of Weights and Measures is required to report the results of the six month sampling and reporting period to the Director of the Arizona Department of Environmental Quality, Governor, Speaker of the Arizona House of Representatives and President of the Arizona Senate (Section 40 of S.B. 1427).

7. Alternative Fuel Vehicles for Local Governments and School Districts, and Federal Government/Low Emission Vehicle Requirements

Arizona Legislature passed S.B. 1427 in 1998 which establishes additional requirements for vehicles owned by cities and towns, and counties in Area A. These provisions also apply to bus fleets operated by the cities, towns, and Regional Public Transportation Authority; school districts with a membership of more than 3,000 located within or which has bus routes running within Area A; the issuance of tax credits or subtractions for alternative fuel vehicles authorized by state law; and the federal government fleets. At a minimum, the alternative fuel vehicles are required to comply with any one of the following:

1. The U.S. Environmental Protection Agency Standards for Low Emission Vehicles pursuant to 40 Code of Federal Regulations Section 88.104-94 or 88.105-94.

2. The vehicle engine is certified by the engine modifier to meet the Addendum to Memorandum 1-A of the U.S. Environmental Protection Agency, as printed in the Federal Register, Volume 62, Number 207, October 27, 1997, pages 55635-55637.

3. The vehicle engine is the subject of a waiver for that specific engine application from the U.S. Environmental Protection Agency's Addendum to Memorandum 1-A requirements and that waiver is documented to the reasonable satisfaction of the Department of Commerce Energy Office.

   The cities, counties, and school districts which have been included within the boundaries of Area A are required to comply with the provisions of A.R.S. 9-500.04 C. through G., 15-349, and 49-474.01 C. through E. relating to the conversion of fleet vehicles to alternative fuels according to the following schedule:

1. At least 18 percent of the total fleet by December 31, 2000.

2. At least 25 percent of the total fleet by December 31, 2001.

3. At least 50 percent of the total fleet by December 31, 2003.

4. At least 75 percent of the total fleet by December 31, 2005.

These provisions do not apply to cities and towns with a population of less than 7,500 according to the most recent U.S. decennial census and that lie outside Area A. Also, S.B. 1427 authorizes that monies in Arizona Clean Air Fund may be used for a public awareness program for alternative fuels. An accounting of the Arizona Clean Air Fund expenditures are to be included in the annual report to the Legislature on the fund activities (A.R.S. 9-500.04, 15-349, 41-1516, 49-474.01, 49-573 and Section 42 of S.B. 1427).

In 1999, the Arizona Legislature passed H.B. 2254 which requires an operator of a United States government owned vehicle fleet based primarily in this state that does not comply with the statutory timetable and percentage goals for alternative fuel vehicles to file a report with the Arizona Department of Commerce Energy Office, the House of Representatives Federal Mandates and States' Rights and Environment Committees, or their successor committees, and the Senate Government and Environmental Stewardship and Commerce, Agriculture and Natural Resources Committees, or their successor committees. The report will include the total number of vehicles in the operator's fleet by class and the percentage that is capable of operating on alternative fuel. The operator is required to file the report on or before October 1, 1999, April 1, 2000 and October 1, 2000.

An operator of a fleet that does not file a report as prescribed will not operate a vehicle in Area A as defined in A.R.S. 49-541 ninety days after the reporting date. Once an operator of a fleet files the report, this subsection will not apply (A.R.S. 49-573 D. and E.).

8. <u>Alternative Fuel Vehicles for State Government/Low Emission Vehicle Requirements</u>

Arizona Legislature passed S.B. 1269 in 1998 which requires the Director of the Arizona Department of Administration (DOA) to appoint a State Motor Vehicle Fleet Alternative Fuel Coordinator to develop, implement, document, monitor and modify as necessary a Statewide Alternative Fuels Plan in consultation with all state agencies and departments that are subject to the alternative fuel requirements. Specifically, the plan is to include the agencies currently exempt from the state fleet alternative fuel conversion requirements (Arizona Department of Public Safety, Arizona Department of Corrections, Universities and Community Colleges, and Arizona State School for the Deaf and the Blind). These agencies are to submit their programs for alternative fuels and fuel economy to the Coordinator.

The Coordinator is required to approve all vehicle acquisitions by the state and assume several functions of the Director relating to the acquisition of alternative vehicle fuel (AFVs) refueling facilities, the development of the vehicle fleet energy conservation plan and the identification of the appropriate AFVs for each state agency. The legislation requires an increasing percentage of new state vehicles weighing less than 8,500 pounds purchased for operation in Maricopa and Pima counties, including all of the agencies exempted from the DOA fleet, to be capable of operating on alternative fuels. The schedule is as follows:

- 10 percent of all 1997 model years purchased
- 15 percent of all 1998 model years purchased
- 25 percent of all 1999 model years purchased
- 50 percent of all 2000 model years purchased
- 75 percent of all 2001 model years purchased

In addition, S.B. 1269 requires an increasing percentage of the AFVs weighing less than 8,500 pounds purchased for operation in Maricopa County to comply with the Environmental Protection Agency's standards for Low Emission Vehicles (LEVs) starting in model year 2000. The schedule is as follows:

- 40 percent of model year 2000 AFVs
- 50 percent of model year 2001 AFVs
- 60 percent of model year 2002 AFVs
- 70 percent of model year 2003 AFVs

Other provisions in S.B. 1269 include a deadline of December 31, 1999, for the Arizona Department of Administration to convert 40 percent of the DOA administered state fleet to alternative fuels. Fire suppression vehicles are excluded from the alternative fuel conversion requirements for the state fleet. For state agencies that use alcohol fueled AFVs, it must be demonstrated to the Director of DOA that the fuel for the vehicle is available within a ten-mile radius of the primary home base for that vehicle.

Regarding reporting requirements, all state agencies, including those exempted from the state fleet, are required to report annually to the Director of DOA on vehicle costs, operation, maintenance, mileage and any other information that the Director deems necessary for the submittal of the annual report to the Legislature and the Governor. The Director of the DOA is required to submit an annual report to the Legislature, the Governor and each of these branches budget offices that provides information about the state fleet including detailed information regarding the conversion of the fleet to alternative fuels (A.R.S. 28-5805 and 41-803).

9. <u>Alternative Fuel Vehicle and Equipment Tax Incentives/Low Emission Vehicle Requirements</u>

Arizona Legislature passed H.B. 2237 in 1997 which extends the existing individual and corporate tax credit for the purchase or conversion of an alternative fuel vehicle or the purchase of an alternative fuel delivery system through 2001 and expands the tax credit to include minimum three year leases of an alternative fuel vehicle. It also increases the tax credit to $1,000 from $500 in 1997 and $250 in 1998 (A.R.S. 43-1086).

In 1998, the Arizona Legislature passed S.B. 1269 which provides a variety of tax incentives and financial assistance to encourage the use of alternative fuel vehicles (AFVs). The definition of alternative fuel is expanded to include an emulsion of water-phased hydrocarbon fuel that contains at least 20 percent water and that complies with one of three specified EPA standards and in combination of at least 70 percent alternative fuel and not more than 30 percent petroleum-based fuel for an engine that meets an equivalent of the EPA Low Emission Vehicle (LEV) standard.

The following tax incentives are provided in the bill:

1. AFV's and alternative fuel conversion equipment are exempt from the retail and personal property rental classifications and use taxation.

2. Corporate and individual income taxpayers are authorized to take both the AFV and equipment subtraction and credits for AFVs and equipment, as well as obtain a grant from the Arizona Clean Air Fund.

3. Individual and corporate income tax credits for tax years 1998 through 2001 are increased from $1,000 to $2,000 for the purchase, lease, or conversion of a dedicated AFV or purchase of a dedicated alternative fuel delivery system. The maximum credit for a bi-fueled AFV remains at $1,000.

4. Nonrefundable individual and corporate income tax credits for tax years 1998 through 2001 are authorized for expenses associated with constructing or operating an alternative fuel fueling station. The amount of the credit for a public-accessible station or a station dispensing renewable fuel is 50 percent of the costs incurred, up to $400,000. For other stations, the credit is the lesser of 25 percent of the costs incurred or $200,000.

5. The maximum corporate income tax subtraction for the purchase of a new AFV is increased from $5,000 to $10,000. This becomes effective for taxable years after December 31, 1997.

6. The maximum corporation income tax subtraction for the conversion to an AFV is increased from $3,000 to $5,000. This becomes effective for taxable years after December 31, 1997.

7. Nonrefundable individual and corporate tax credits are authorized for the

purchase or lease (for at least three years) of original equipment manufactured AFVs. For tax years 1999 through 2011, the amount of credit ranges from 50 to 90 percent of the incremental cost above the cost of a conventionally fueled vehicle, based on the emissions levels of the AFV. For tax years 2012 through 2019, the amount of credit ranges from 25 to 75 percent of the incremental cost above the cost of a conventionally fueled vehicle, based on the emissions levels of the AFV.

8. Grants from the Arizona Clean Air Fund (ACAF) are made available for AFVs purchased or leased and the amount of the grant is increased from $1,000 to $2,000.

Passed by the Arizona Legislature in 1998, S.B. 1427 tax credits or subtractions for alternative fuel vehicles authorized by state law will only be allowed if the vehicle meets one of the following:

1. The vehicle is certified to meet at a minimum the U.S. Environmental Protection Agency Low Emission Vehicle Standard pursuant to 40 Code of Federal Regulations Section 88.104-94 or 88.105-94.

2. The vehicle meets the requirements of the Addendum to Memorandum 1-A, issued by the U.S. Environmental Protection Agency, as printed in the Federal Register, Volume 62, Number 207, October 27, 1997, pages 55635-55637.

3. The vehicle is the subject of a waiver for that specific engine application from the U.S. Environmental Protection Agency's Memorandum 1-A requirements and that waiver is documented to the reasonable satisfaction of the Department of Commerce Energy Office (A.R.S. 1-215, 41-1516, 42-5061, 42-5071, 42-5159, 43-1026, 43-1086, 43-1128.01, and 43-1174).

10. <u>Public Awareness Program for Alternative Fuels</u>

Arizona Legislature passed S.B. 1427 in 1998 which allows monies from the State Clean Air Fund to be used to conduct public awareness programs for alternative fuels (A.R.S. 41-1516).

11. <u>Voluntary Gasoline Vehicle Retirement Program/Maricopa County Travel Reduction Program</u>

Maricopa County is in the process of revising its Trip Reduction Ordinances to include voluntary vehicle trade-outs. The proposed revisions will allow trade-outs that have been completed after October 16, 1996 to be used to achieve the emission reduction goals established under the ordinance. This measure is assumed to be a mechanism for implementation of the Trip Reduction Program goals.

12. Mass Transit Alternatives

Many cities are pursuing a variety of mass transit alternatives. These include feasibility studies to evaluate the need and general location for high-capacity transit corridors throughout the metropolitan area, efforts to obtain Federal assistance for high-capacity rail transit and plans for local taxes to support expanded transit service.

13. Special Event Controls-Required Implementation from List of Approved Strategies

Several cities are evaluating options for managing parking and traffic associated with special events. An important aspect is the linkage of reducing vehicular congestion with alternative modes of travel.

14. Encourage the Use of Temporary Electrical Power Lines Rather than Portable Generators at Construction Sites

A number of local governments are taking steps to begin implementing this measures. Efforts include providing information brochures to developers, adjusting electrical codes, identifying reusable equipment, and conducting pilot projects.

15. Public Information Program on Wood Stoves and Wood Heat

Maricopa County, which was identified as the suggested implementing agency, is continuing the implementation of the public information and education program to inform and educate citizens about issues pertaining to woodburning. The program includes two hotlines, fax notifications of high air pollution advisories, information sheets, and newspaper articles. Maricopa County also indicated that it will post High Pollution Advisories on the Maricopa County Environmental Services Home Page and distribute educational brochures to promote clean-burning fireplaces. This measure is assumed to be a mechanism for implementing the Residential Woodburning Restriction Ordinances which is reflected in the base emission inventories.

16. Encourage Limitations on Vehicle Idling

The Regional Public Transportation Authority (RPTA) updated its engine idling policy in June 1996. The RPTA will continue to work with member jurisdictions to promote environmentally sensitive transit operations practices and policies. Promoting vehicle idling limitations and other environmentally sensitive transit operations practices and policies are included within the ongoing annual budgets of the RPTA and its member jurisdictions.

17. Voluntary No-Drive Days

Arizona Legislature passed S.B. 1427 in 1998 which changes the Voluntary No Drive Days Program from a winter-time program to a year round program. Maricopa and Pima Counties are required to implement the program (A.R.S. 49-506).

18. Analysis of Intersource Credit Trading and Banking Program

Arizona Legislature passed S.B. 1427 in 1998 which appropriated $75,000 from the State General Fund to the Arizona Department of Environmental Quality for fiscal year 1998-1999 for the analysis of the environmental and economic feasibility of an intersource credit trading and banking program in Arizona for emission sources within the same nonattainment area, maintenance area, or modeling domain. In order to demonstrate environmental feasibility within a nonattainment area, maintenance area, or modeling domain, all emissions trading actions must result in overall reductions in total emissions within the same nonattainment area, maintenance area, or modeling domain. The general fund appropriation must be matched by an equal expenditure of monies from gifts, grants, or donations or the general fund monies revert to the State General Fund by the end of the fiscal year (Section 39 of S.B. 1427).

19. Expansion of Public Transportation Programs

Many individual cities, as well as regional agencies, have ongoing public transportation programs. Most recently a number of local jurisdictions are considering sales tax sources to provide funding for service expansions.

20. Employer Rideshare Program Incentives

Many local governments are providing incentives for employees to participate in the rideshare program. These employers have designated Rideshare Coordinators and are promoting their incentives programs through public awareness campaigns, employee matching services, and new employee information. Incentives include preferential parking for carpools, bus subsidies, emergency rides home, and weekly or monthly prize drawings. Some jurisdictions have also included telecommuting and alternate work schedule options in their Trip Reduction Plans. Funding for these programs are usually allocated through the annual budget process. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

21. Preferential Parking for Carpools and Vanpools

Many cities and towns are providing preferential parking spaces for carpools and vanpools as part of their Trip Reduction Plans. Funding for this measure has been provided through each jurisdiction's individual Trip Reduction Program budget in conjunction with other various local departments such as Transportation or Public Works. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

22. Reduce Traffic Congestion at Major Intersections

In addition to congestion reductions from traffic signal coordination and intelligent transportation systems (covered under those measures), many local governments have identified other ways of reducing traffic congestion at major intersections. These methods include bus pullouts, additional turn lanes, parking access controls, and median treatments.

23. Site-Specific Transportation Control Measures

This measure is closely related to Reduce Traffic at Major Intersections. Activities being pursued by jurisdictions to implement site-specific improvements are generally directed at major intersections, and include turn lanes, parking access controls, and median work. In addition, under this measure transportation management associations (TMAs) covering 14 different areas were identified. TMAs provide implementation methods for the Trip Reduction Program.

24. Encouragement of Bicycle Travel

Many local governments are pursuing continuing improvements in bicycle information and educational programs. These programs include safety, educational and promotional flyers, posters, brochures and bike events to encourage safe use of bicycles and safe commuting. Also bike plans and regional bike maps are prepared. This measure is assumed to be an implementing mechanism for the Trip Reduction Program.

25. Development of Bicycle Travel Facilities

A number of cities and towns are continuing programs to improve and expand bicycle facilities. Those programs cover provisions for bike lanes on arterial streets installation of bike racks, showers and lockers, and construction of multi-use paths accessible to bikes. This measure is assumed to be an implementing mechanism for the Trip Reduction Program.

26. Alternative Work Schedules

Many local governments are encouraging alternative work schedules. Strategies, such as 4-day, 10-hour work weeks, 9-day, 80-hour work plans, staggered work schedules, and Flextime have been successfully implemented by many of the local governments. Some jurisdictions have set goals to incorporate up to 85 percent of their employees into some type of alternative work schedule. This measure is usually funded through individual departmental budgets. This measure is assumed to be an implementation mechanism for the Trip Reduction Program. Also, work schedule adjustments as a result of the Governor’s authority to declare an air pollution emergency are included in the base case air quality inventories.

27. Land Use/Development Alternatives

Many local governments are encouraging land use patterns that support public transit and other alternative modes of travels. General plans outline goals, objectives and policies to promote a balanced transportation system. Development master plans strive to reduce dependency on automobiles, increase densities, provide for shorter trips, and consider alternative modes of travel. Also, plans and fee structures which encourage development in-fill have been adopted. Land use patterns and plans are reflected in the socioeconomic databases used in the air quality/transportation modeling process.

28. Encouragement of Pedestrian Travel

This measure is closely related to Land Use/Development Alternatives. Activities pursued by local governments to encourage pedestrian travel are included in land use/development planning. Efforts to increase densities, shorten trip lengths, and promote alternative transportation modes all encourage pedestrian travel. Land use patterns and plans are reflected in the socioeconomic databases used in the air quality/transportation modeling process.

29. Restrictions on the Use of Gasoline-Powered Blowers for Landscaping Maintenance

Many local governments are reducing the use of gasoline powered blowers. These governments will reduce the use of blowers by restricting them during certain hours and replacing them with vacuums and brooms.

30. Alternative Fuels for Fleets

The RPTA and its member agencies have begun an aggressive campaign to purchase, convert, and replace older, higher polluting diesel buses. Additional commitments include the delivery of 180 low floor, forty foot buses which operate solely on liquefied natural gas.

Funding comes from the RPTA and member agency capital improvement budgets. Incremental costs for alternative fuel vehicles may be reimbursed by the Arizona Department of Commerce Energy Office through the Clean Air Fund.

31. Areawide Public Awareness Programs

The RPTA is carrying out an area-wide public awareness program. The program is targeted to employers and employees affected by the Maricopa County Trip Reduction Program (TRP), employers not affected by TRP and the general public. The awareness program includes paid radio and television advertising for eight weeks during the winter pollution season, promotional mailings to TRP participants up to four times per year, workshops to increase participation in Clean Air

Campaign events, and events to increase awareness of alternative modes of transportation and work schedules. High Pollution Advisory faxes are also sent to over 700 Valley employers during the winter and summer high pollution season when it is “forecast” to potentially exceed federal air quality standards. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

32. Encouragement of Vanpooling

The RPTA is assisting employers in the formation of new vanpools through presentations to employers, providing materials to all interested parties, conducting vanpool group formation meetings, and providing vanpool matching. The RPTA staff also assist employers in promoting vanpools and will encourage employers to provide subsidies to their employees. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

33. Trip Reduction Program

The RPTA is under contract with Maricopa County to provide services to employers affected in the Trip Reduction Program under Arizona Revised Statutes 49-581 through 49-593. The RPTA provides formal training, one-on-one assistance, facilitates Transportation Management Associations and provides informational materials to over 1,250 employers in Maricopa County with 50 or more employees at a site. The Trip Reduction Program affects approximately 580,000 employees and students at 2,500 sites county-wide. The benefits of the Trip Reduction Program are reflected in the base case modeling.

34. Park and Ride Lots

The RPTA is continuing to work with member jurisdictions, private entities, and employers in the development, design, and implementation of new Park and Ride facilities in locations where they are needed. Park and Ride activities are in the on-going annual budgets of the RPTA and its member jurisdictions. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

35. Encouragement of Telecommuting, Teleworking, and Teleconferencing

The RPTA is carrying out a regional effort to increase telecommuting in the area. The RPTA provides training classes, on-site assistance, and an Internet web-site to valley employers interested in implementing telecommuting programs. This effort is on-going and is funded as part of the budget for the Regional Rideshare Program. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

36. Promotion of High Occupancy Vehicle (HOV) Lanes and By-Pass Ramps

The regional effort to promote HOV lanes is incorporated into the Maricopa County Trip Reduction Program and the Clean Air Campaign. As part of the regional effort to promote HOV lanes and by-pass ramps, the RPTA has made a commitment to coordinate Employer Transportation Fairs, periodic Transportation Management Association meetings, and mailings to employers prior to new HOV lane segment openings. This measure is assumed to be an implementation mechanism for the Trip Reduction Program.

37. <u>Voluntary Vehicle Repair and Retrofit Program</u>

Arizona Legislature passed S.B. 1427 in 1998 which requires Maricopa County to establish and coordinate a Voluntary Vehicle Repair and Retrofit Program in Area A. The County is required to coordinate the program with the Arizona Department of Environmental Quality and Arizona Department of Transportation. The program is required to begin by January 1, 1999 and provide for quantifiable emission reductions based on actual emissions testing performed on the vehicle before repair and retrofit.

A vehicle owner may participate in the program if all of the following criteria are met: 1. The owner is willing to participate in the program. 2. The vehicle is functionally operational. 3. The vehicle has been titled in this state and registered in Area A for at least twenty-four months. 4. The vehicle is at least twelve years older than the current model year passenger car or light duty truck. 5. The vehicle fails the emissions test. It is important to note that vehicles that are not required to take the emissions inspection test are not eligible to participate in the program.

The County is required to develop a Pilot Emissions Control Repair and Retrofit Program in cooperation with the ADEQ that has the following provisions:

1. Vehicle owners who qualify for the repair and retrofit program will pay the first $100 as a co-payment.

2. Vehicle owners that require more than $500 in repair costs or $650 in retrofit parts and labor costs are not eligible unless the vehicle owner chooses to pay additional costs.

Diesel powered motor vehicles with a gross vehicle rating of more than 8,500 pounds that are registered in Area A which fail any random roadside vehicle test conducted by the State are eligible for up to $1,000 in repair or retrofit costs from the program. Qualified vehicle owners will be responsible for one-half of the costs of the qualified repairs and the other one-half of the costs will be funded from the program up to $1,000. No more than 20 percent of the program funds in any year may be used for these purposes.

S.B. 1427 also establishes a Voluntary Vehicle Repair and Retrofit Program Fund consisting of monies appropriated by the Legislature and political subdivisions and gifts, grants, and donations. S.B. 1427 includes an appropriation of $800,000 from the State General Fund in fiscal year 1998-1999 for the Voluntary Vehicle Repair and Retrofit Program Fund.

The County Board of Supervisors is required to appoint an advisory committee composed of representatives from the Arizona Department of Transportation, Arizona Department of Environmental Quality, and the parties affected by the Voluntary Vehicle Repair and Retrofit Program, including automobile hobbyists and the automotive after-market products industry. The role of the committee is to advise and make recommendations on the development and implementation of the program.

By December 1 of each year, the County is required to prepare a report on the Voluntary Vehicle Repair and Retrofit Program that includes the number of vehicles repaired or retrofitted by model year, the cost effectiveness of the program in terms of dollars spent per ton of vehicle emission reductions, any recommendations for improving the effectiveness of the program, and the administrative costs of the program. The report is required to be submitted to the Arizona Department of Environmental Quality, Arizona Department of Transportation, Speaker of the House of Representatives, President of the Senate, Governor, Secretary of State, and Director of the Arizona Department of Library, Archives, and Public Records (A.R.S. 49-474.03 and Section 34 and 36 of S.B. 1427).

38. Oxidation Catalyst for Heavy Duty Diesel Vehicles

Arizona Legislature passed H.B. 2237 in 1997 which requires cities, towns, Maricopa County, school districts, the state and the federal government to install a technology (oxidation catalyst) on their heavy duty diesel vehicles if the entities receive a waiver to opt out of the alternative fuel requirements for fleets. The heavy duty diesel vehicles with a gross vehicle weight of 8500 pounds or more manufactured in or before model year 1993 would have the catalyst installed based upon the following time schedule in A.R.S. 49-555:

a. 25 percent of the diesel fleet vehicles by December 31, 1998.
b. 40 percent of the diesel fleet vehicles by December 31, 1999.
c. 60 percent of the diesel fleet vehicles by December 31, 2000.
d. 80 percent of the diesel fleet vehicles by December 31, 2001.
e. 100 percent of the diesel fleet vehicles by December 31, 2002.

The technology is to be effective at reducing particulate emissions by at least 25 percent and be approved by the Environmental Protection Agency pursuant to the Urban Bus Engine Retrofit/Rebuilt Program. This measure applies to Area A which is generally the nonattainment area (A.R.S. 9-500.04, 15-349, 41-803, 49-474.01, 49-573 and 49-555).

39. Require Pre-1988 Heavy-Duty Diesel Commercial Vehicles Registered in the

Nonattainment Area to Meet 1988 Federal Emission Standards; Provide Incentives to Encourage Voluntary Accelerated Vehicle Replacement by the Year 2004

Arizona Legislature passed S.B. 1002 in 1996 which requires that beginning on January 1, 2004, a diesel powered motor vehicle with a gross vehicle weight of more than 26,000 pounds and which gross weight fees are paid pursuant to Section 28-206 in Area A will not be allowed to operate in Area A unless it was manufactured in or after the 1988 model year or is powered by an engine that is certified to meet or surpass emissions standards contained in 40 Code of Federal Regulations Section 86.088-11. This does not apply to vehicles that are registered pursuant to Title 28, Chapter 2, Article 1.1. (A.R.S. 49-542 F.7.).

Regarding incentives to encourage accelerated replacement by the year 2004, the Arizona Legislature passed S.B. 1427 in 1998 which provided that diesel powered motor vehicles with a gross vehicle rating of more than 8,500 pounds that are registered in Area A which fail any random roadside vehicle test conducted by the State are eligible for up to $1,000 in repair or retrofit costs from the Voluntary Vehicle Repair and Retrofit Program. Qualified vehicle owners will be responsible for one-half of the costs of the qualified repairs and the other one-half of the costs will be funded from the program up to $1,000. No more than 20 percent of the program funds in any year may be used for these purposes. The Voluntary Vehicle Repair and Retrofit Program is administered by Maricopa County in coordination with the Arizona Department of Environmental Quality and Arizona Department of Transportation (A.R.S. 49-474.03 and Sections 34 and 36 of S.B. 1427).

VII-3. Future Year Emission Inventory

This section summarizes the development of the 2006 and 2015 carbon monoxide (CO) emission inventories for use in the Urban Airshed Model (UAM). The UAM Emissions Preprocessor System (EPS2.0) [2] was used to process the emissions inventories including point, area, aviation, and nonroad mobile sources. The onroad mobile emissions, which are the major source of CO emissions in the Maricopa County Nonattainment Area, were generated by the EPA MOBILE6 model and M6Link. For the purposes of this modeling effort, “MOBILE6" may refer to either the MOBILE6.0 or MOBILE6.2 versions, both of which should produce identical carbon monoxide emission factors given the same inputs. M6Link is a MAG software program applied at the transportation link level to generate gridded mobile source emissions compatible with UAM. CO emissions from sources other than onroad mobile emissions, including point, area, and nonroad mobile sources, are considered “background” emissions. All onroad mobile and background emissions were merged by EPS2.0 to be ready for input to UAM. The discussion of the base year (1994) inventory may be found in Section III-1.

The projected future-year inventory includes the committed maintenance measures package. The future year emission inventory includes projected emission reductions resulting from committed control measures that were implemented after 1994, as described in Section VII-2-1.

VII-3-1   ONROAD MOBILE SOURCE EMISSIONS

The first step in developing onroad mobile emissions is to estimate emission factors. A very large array of mobile emission factors is required by the M6Link model to produce a complete motor vehicle emissions inventory. These factors, in units of grams per mile, are multiplied by vehicle miles traveled (VMT) in each grid cell of the modeling domain to produce the onroad mobile source emissions estimates. These factors are unique by vehicle type, vehicle age, hour of the day, and facility type the vehicle is driving on. Emission factors are also influenced by several other parameters, including fuel formulations, specific scenario conditions, and vehicle fleet characteristics.

In this analysis, the emission factors for the years 2006 and 2015 have been obtained from the EPA MOBILE6 model. Appendix VII-i presents a detailed description of the emission factor estimation procedure for 2006 and 2015. The 2006 and 2015 maintenance year inventories reflect the impact of control measure commitments contained in the Revised CO Plan where appropriate. Detailed modeling methodologies for the control measures may be found in Section VII-2-1. A detailed overview of the MOBILE6 and M6Link models may be found in Section III-1-1 of this document.

This section will concentrate on presenting a brief description of how the onroad analysis for the 2015 committed maintenance package analysis reflects the future year and effects of the measures. Please note that the 2006 onroad analysis for the committed maintenance package was performed in a similar manner to the 2015 analysis. The committed measure package maintenance year inventory reflects the impact of the maintenance measures used for numeric credit, as documented in Section VII-2-1. Mobile source emissions were adjusted to reflect these measures via the following steps:

- MOBILE6 was run for both the I/M and non-I/M cases. In the case of the MOBILE6 runs reflecting the I/M program, one input to the MOBILE6 model is a fraction of tested vehicles that receive waivers from the I/M program. The committed maintenance measure <u>One-Time Waiver from Vehicle Emissions Test</u> was modeled by changing the base case waiver rates to reflect the effects of these measures.

- The output from MOBILE6 runs from the I/M case versus the non-I/M case are weighted in the M6Link program. The base case weighting fractions of 89.6 percent I/M and 10.4 percent non-I/M were changed to 91.6 percent versus 8.4 percent to reflect the implementation of the control measure <u>Tougher Enforcement of Vehicle Registration and Emission Test Compliance</u>.

- MOBILE6 runs for both the I/M and non-I/M case accept as input data reflecting the properties (oxygen content, vapor pressure, and sulfur content) of the gasoline used by vehicles in the modeling area. The effects of the control measure <u>Winter Fuel Reformulation: California Phase 2 Reformulated Gasoline with 3.5 Percent Oxygen Content November 1 Through March 31</u>, the gasoline properties were changed from the base case fuel properties in 1994 to expected fuel properties based upon this control measure.

- MOBILE6 runs for the I/M scenario include as input data about the nature of the I/M program itself. In the case of enhanced I/M programs, these data include the emission levels allowed by the program (cutpoints) before a vehicle is failed for excessive emissions. The benefits from the control measure Phased-In Emission Test Cutpoints were approximated by inputting I/M147 cutpoints into the MOBILE6 model. Additionally, the assumptions include the use of an on-board diagnostic (OBD) test for all 1996 and newer vehicles with an exemption from testing for vehicles of the current and four most recent model years older than the current year.

- The emission effects of the control measures Coordinate Traffic Signal Systems and Develop Intelligent Transportation Systems were calculated using MOBILE6 emission factors with new idling assumptions and speeds. The change in total emissions expected from these two measures were calculated using spreadsheet calculations incorporating the MOBILE6 emission factors, rather than through a full M6Link run. The resulting percent reductions in total emissions were applied to the UAM-ready M6Link output files using the EMSCOR utility.

The outputs from the M6Link program are grown by 15 percent for the 2015 analysis and 6 percent for the 2006 analysis, regardless of hour of the day or location in the modeling domain because of an expected increase in population projections for the State. The Arizona Department of Economic Security (DES) is in the process of developing new population projections for the State and counties based on the 2000 Census. These projections will not be available from DES until sometime in 2003. However, preliminary data indicate that the new projections will be about 15 percent higher for Maricopa County in 2015 and 6 percent higher in 2006. This factor was also applied with the EMSCOR utility. The growth expected due to increasing socioeconomic projections is partially offset by a reduction in expected emissions due to the Intelligent Transportation Systems and Traffic Signal Synchronization control measures, whose effects are also incorporated with EMSCOR.

VII-3-2 BACKGROUND EMISSIONS

Background emissions are defined as all CO emissions except those from onroad mobile sources. The background emissions include point sources, area sources such as wood burning fireplaces, and nonroad mobile sources. The modeling inventories for background sources for 2006 and maintenance year 2015 were projected from the 1999 periodic emission inventory made available in November 2001 [16].

Creation of the background emissions of the committed maintenance measure package for 2006 and the maintenance year takes place in three steps: (1) projection to modeling year, (2) temporal adjustment to the episode days (described in Section 3) and (3) allocation of the emissions spatially. These steps are accomplished using the UAM Emissions Preprocessor System (EPS2.0).

Four of the measures used for numeric credit impact the background sources. Nonroad emissions were affected by Measure 1 “CARB Phase 2 gasoline”, Measure 4 “defer government emissions”, and Measure 9 “off road vehicle and engine standards” (see Table VII-1 for the measure numbers). The CO COMPLEX Model was used to evaluate the impact of Measure 1 on nonroad emissions. To model the impact of Measure 4, the temporal distribution of two-stroke nonroad emissions was adjusted to reflect local

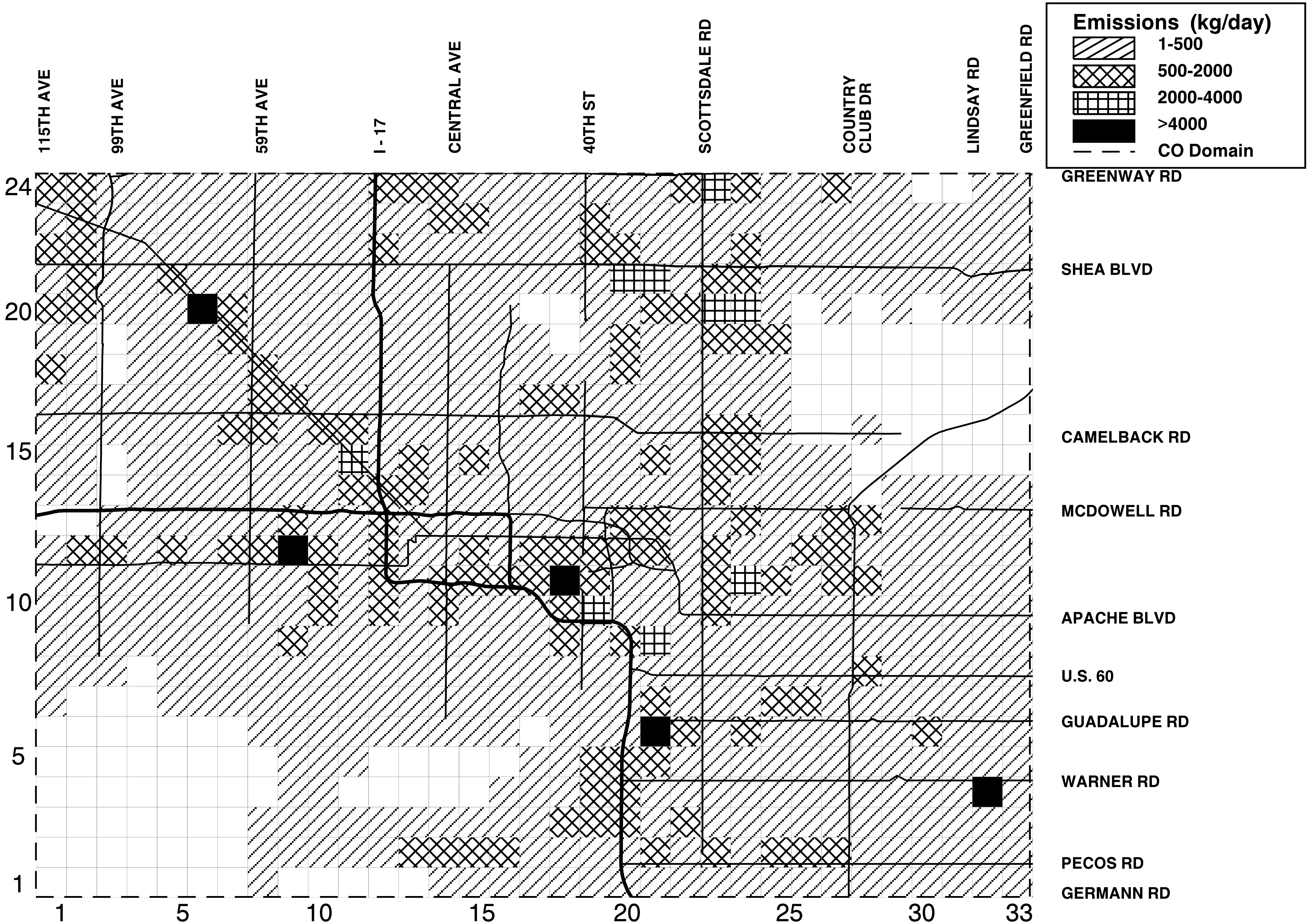


FIGURE VII-3. The spatial distribution of the 2015 background emissions
Maximum Value = 12,759 kg/day at (32,4). Total = 238,252 kg/day

government commitments to reduce their use of nonroad equipment during afternoon hours. Six percent of the two-stroke nonroad engine emissions occurring after 2:00 p.m. were reallocated to occur earlier in the day. Area source emissions were affected by Measure 8 “clean burning fireplace Ordinances”. The impact of measures 1, 8 and 9 was applied through the CNTLM module of EPS2.0. The M6Link output reflecting the impact of the control measures described above was merged with the background emissions reflecting the adjusted nonroad mobile and area source emissions to create the 2006 and 2015 committed measure package maintenance year inventories. The spatial distribution of background emissions in 2015 is presented in Figure VII-3.

Projection of Background Inventory

Emissions for source types other than onroad mobile are developed for a base year and then projected to 2006 and 2015 through the application of appropriate growth factors. The growth factors are included in Appendix VII. It is important to note that the growth factors were based on the population projections approved by the MAG Regional Council in June 1997 and developed from the 1995 Special Census. The 2006 and 2015 employment factors by SIC were based on projections prepared by the Arizona Department of Economic Security in August 1997. The background emissions, except those from the peaking power plants, were grown by 6 percent for 2006 and 15 percent for 2015, regardless of hour of the day or location in the modeling domain, because of an expected increase in population and employment projections for the State. The Arizona Department of Economic Security (DES) is in the process of developing new population projections for the State and counties based on the 2000 Census. These projections will not be available from DES until sometime in 2003. However, preliminary data indicate that the new projections will be about 6 percent and 15 percent higher for Maricopa County in 2006 and 2015 respectively. The emission inventory reflects the combined package of committed maintenance measures.

For area and nonroad mobile sources, the EPS2.0 program CNTLEM is used to project the base case inventory to future years. For point sources, a utility program is used to project any facility-specific source, because CNTLEM cannot apply facility-specific growth factors.

Several additional power plant units have been issued permits since 1994. To properly account for the CO emissions from the growing number of power plants, MCESD has provided estimates of the emissions from the existing peaking power plants and the new base load units for 2015, as displayed in Table VII-3. The power plant emissions used in the 2006 and 2015 CO simulations are assumed to be at their maximum levels, including emissions from the maximum hours defined in the permits or applications for starting up and shutting off units. For all other point sources in the inventory, typical CO season day emission rates are projected to 2006 and 2015. The CO emissions from point sources for a Friday in December increase from 2.5 metric tons in 1994 to 32.2 metric tons in 2015.

The aviation emission estimates were obtained from the MAG Aviation Emissions Preprocessor, described in the report by Lee Engineering (November 1996) [5]. Airport activity levels were based on surveys conducted at each airport which included questions about aircraft activity, ground service vehicle use, fuel use, and coating operations. The activity data for the preprocessor were collected through airport surveys conducted in 1995 which is the base year for the preprocessor. The 1995 activity data were grown to 1999 by applying a growth factor to the 1995 hourly activity levels input into the aviation preprocessor. The growth factors were developed using data from the Maricopa Association of Governments (MAG) report (2001) [13] for all local airports in the modeling domain. Specifically, the hourly activity levels were grown by applying a ratio of 1999 versus 1995 activity levels developed from the MAG report [13] versus the base numbers in the aviation preprocessor. Table VII-4 for aviation related sources reflect the final 1999 aviation emissions (i.e. ground service vehicles and aircraft) for all local airports in the modeling domain. It is important to note that the preprocessor output replaced the 1999 Periodic Inventory aviation-related emissions, because the preprocessor output, as previously discussed, was based on survey results and episode-specific meteorological conditions. The 2006 and 2015 growth factors presented in Table VII-5 for aviation related sources reflect growth from 1999 to 2006 and 2015. The "Growth Reference" column represents aviation carrier operations, general and taxi operations at Sky Harbor Airport. The actual 1999 and 2015 forecasted Sky Harbor aviation operations were provided in the MAG report [13].

Allocation of the Emissions Spatially

Point sources are spatially allocated on the basis of the location (UTM coordinates or latitude/longitude) of each source. Area and nonroad mobile source emissions, with the exception of aviation-related emissions, are spatially distributed based on surrogate factors that indicate emission level or activity. For this analysis, projections based on MAG land use data (1990 and 1995) have been used to determine the spatial allocation factors for all of the area and nonroad mobile sources except for aviation. The 1995 land use was employed in developing all of the area and nonroad mobile spatial surrogates with the exception of non-developable forest, railroad, agricultural stockyards, and other uses that were not available in the 1995 land use data. For these categories, 1990 land use data was used as the surrogate. The spatial allocation of emissions remained consistent between 2006 and maintenance year 2015.

VII-3-3 SUMMARY OF THE MODELING INVENTORIES

The onroad mobile emissions output by M6Link are merged with the background emissions output by EPS2.0 to create a UAM compatible emission file. The 1994 base year and 2006 and 2015 CO maintenance inventories are summarized in Table VII-6. In all of the inventories, onroad mobile source emissions represent the largest source of CO emissions in the modeling domain. With the implementation of the committed maintenance measures and stricter Federal controls on vehicles and fuels, onroad mobile emissions decrease by 23.8 percent from 1994 to 2015. Area source emissions increase 72.4 percent between 1994 and 2015, due to anticipated growth in regional vehicle travel and population. Over this period, point source emissions increase almost twelve-fold, as a result of expected increases in power plant emissions. Nonroad mobile source emissions increase about ten percent, as control measures do not fully offset growth in the number of nonroad engines. Total emissions with implementation of the committed maintenance measures decrease by approximately 14 percent between 1994 and 2015.

Table VII-3. Projected 2015 CO emission rates for power plants in the modeling domain (source: Maricopa County Environmental Services Department).

Plant Name		Annual PTE (tons/yr)	PTE Normal Operation (lbs/hr)	Startup/shutdown (lbs/hr)	Startup/shutdown: no consecutive hrs.	stack ht (ft)	diameter (ft)	velocity (ft/sec)	temp (o F)
SRP: Kyrene									
	Boiler Unit 1	166	39.1	----		23.16	8.00	47.00	350
	Boiler Unit 2	281	66.1	----		36.58	10.99	43.98	338
	Unit 4 CT	412	79.4	----		37.00	18.76	91.97	894
	Unit 5 CT	400	74.7	----		31.98	18.93	146.98	1190
	Unit 6 CT	400	74.7	----		31.98	18.93	146.98	1190
	NEW Unit K7 CC	141.6	17.3	760.2	8	149.96	18.01	39.17	181
SRP: Santan									
	Unit 1 CC	380	91.0	----		49.00	13.25	84.20	370
	Unit 2 CC	380	91.0	----		49.00	13.25	85.20	371
	Unit 3 CC	380	91.0	----		49.00	13.25	86.20	372
	Unit 4 CC	380	91.0	----		52.00	13.25	87.20	373
	NEW unit A *	141.6	17.3	760.2	8	149.96	18.01	61.43	181
	NEW unit B *	141.6	17.3	760.2	8	149.96	18.01	61.43	181
	NEW unit C *	141.6	17.3	760.2	8	149.96	18.01	61.43	181
	*Permit application expected fall 2001. Expansion is assumed to be equivalent to 3 x new Kyrene unit (K7 above)								
SRP: Agua Fria									
	Boiler Unit 1	203	46.4	----		120.00	8.00	50.00	300
	Boiler Unit 2	203	46.4	----		120.00	8.00	50.00	300
	Boiler Unit 3	317	72.4	----		123.00	9.25	58.00	242
	Unit 4 CT	512	124.2	----		34.00	23.42	63.50	942
	Unit 5 CT	507	123.0	----		39.00	19.17	92.80	942
	Unit 6 CT	507	123.0	----		39.00	19.17	92.80	942
APS: West Phoenix									
	Unit 1 CC	280	63.93	----		54.00	15.40	70.40	342
	Unit 2 CC	280	63.93	----		54.00	15.40	70.40	342
	Unit 3 CC	**	2.30	360	1 (first hour)	54.00	15.40	70.40	350
		**		180	1 (second hour)				
	Unit 4 CC	**	5.52	435	1	120.00	14.00	66.00	170
	Unit 5 CC, Stack 1	**	10.44	870	1	175.00	18.00	65.00	170
	Unit 5 CC, Stack 2	**	10.44	870	1	175.00	18.00	65.00	170
	Unit 1 Ct	280	63.93	----		32.00	17.17	108.40	846
	Unit 2 Ct	280	63.93	----		32.00	17.17	108.40	846
	** Units 3, 4 and 5 have a combined limit of 184.2 TPY.								
APS: Ocotillo									
	Boiler Unit 1, Stack 1	61	13.9	----		178.00	8.58	55.60	274
	Boiler Unit 1, Stack 2	61	13.9	----					
	Boiler Unit 2, Stack 1	61	13.9	----		178.00	8.58	55.60	274
	Boiler Unit 2, Stack 2	61	13.9	----					
	Unit 1 Ct	53.44	12.2	----		35.00	17.17	108.00	846
	Unit 2 Ct	53.44	12.2	----		36.00	17.17	108.00	846

Table VII-4. 1999 Aviation-Related Emissions by Airport for the Modeling Domain (metric tons per day).

Airport	Ground Service Vehicles	Aircraft	Total
Sky Harbor	4.35	4.19	8.54
Glendale	0.03	0.92	0.95
Scottsdale	0.40	2.04	2.44
Stellar Airpark	0.03	0.34	0.37

Table VII-5. Aviation-Related Growth Projections.

ASC	Description	1999 to 2006 Growth Factor	1999 to 2015 Growth Factor	Growth Reference
2275020000	Aircraft - Air Carrier	1.24	1.46	Carrier Ops
2275050000	Aircraft - General	1.00	0.81	Gen & Taxi Ops
2275070000	Aircraft Auxiliary Power Units	1.00	0.81	Gen & Taxi Ops
2275001000	Aircraft - Military	1.00	1.00	Military Ops
2260008005	Aircraft Support Equipment (2 - stroke gasoline)	1.24	1.46	Carrier Ops
2260008010	Terminal Tractors (2 - stroke gasoline)	1.24	1.46	Carrier Ops
2265008005	Aircraft Support Equipment (4 - stroke gasoline)	1.24	1.46	Carrier Ops
2265008010	Terminal Tractors (4 - stroke gasoline)	1.24	1.46	Carrier Ops
2270008005	Aircraft Support Equipment (Diesel)	1.24	1.46	Carrier Ops
2270008010	Terminal Tractors (Diesel)	1.24	1.46	Carrier Ops

A list of the major background sources (greater than one metric ton/day) for a Friday in December 2006 and 2015 is provided in Tables VII-7. The temporal distribution for all sources combined is shown in Figure VII-4. The temporal distribution for 2006 is nearly identical to 2015 therefore only the 2015 temporal distribution is shown. The spatial allocation of the total CO emission inventory with the committed maintenance measure package is illustrated in Figure VII-5 for the Friday in December 2015. The spatial distribution of emissions is similar between 2006 and 2015; therefore, only the 2015 spatial allocation of emissions is shown. The maximum CO emissions occur in grid cell (32,4), where a peaking power plant is located.

VII-4. Maintenance Demonstration

To demonstrate maintenance of the 8-hour CO NAAQS, the results from the urban airshed modeling analyses should not show predicted 8-hour maximum CO concentrations greater than 9.0 ppm anywhere in the modeling domain for the episode modeled. The maintenance demonstration follows the deterministic procedure prescribed in the EPA Guideline [21].

<u>VII-4-1. UAM ANALYSIS</u>

The purpose of future year simulations is to illustrate the effects of projected emission changes on simulated air quality for a given episode. Spatial locations of peak CO

concentrations in the future year simulations are relevant only to the degree that they reflect emission density patterns and typical wind patterns.

Comparison of the base and future year emission totals was provided in Tables VII-8a and VII-8b. The CO emissions for 2006 are about 13 percent lower than the 1994 emissions estimates for the first simulation day and 3 percent lower for the second simulation day. The lower CO emissions resulted in around 16.7 percent reduction in the maximum CO concentration in 2006, as shown in Table VII-9. Similarly, the CO emissions for 2015 are 14 percent lower than the 1994 emissions estimates for the first simulation day and 12.6 percent lower for the second simulation day. The maximum CO concentration in 2015 is about 25 percent lower than that in 1994. The simulated spatial and temporal concentration patterns are very similar for all three years. Isopleth plots illustrating the 2006 and 2015 daily maximum simulated carbon monoxide eight-hour concentrations for the episode are provided in Figures VII-6 and VII-7.

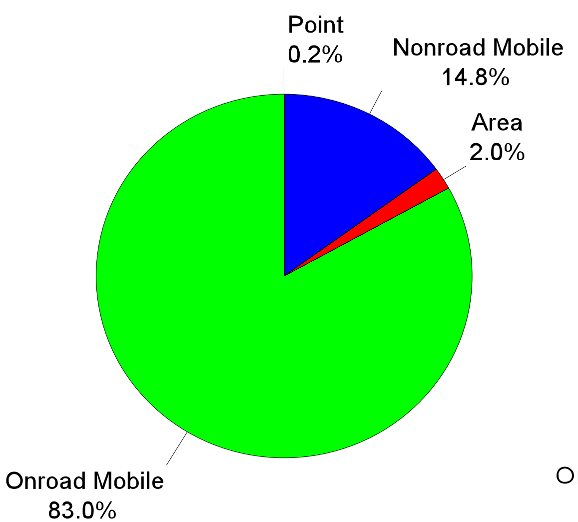
<u>VII-4-2. MICROSCALE ANALYSIS</u>

The microscale analysis for 2006 and 2015 included the effects of the combined package of committed maintenance measures consistent with the steps discussed above, although differences may exist because of the different models used in the microscale versus UAM emission inventory preparation analyses. Consistent with the M6Link model, MOBILE6 emission factors are input to the CAL3QHC model.

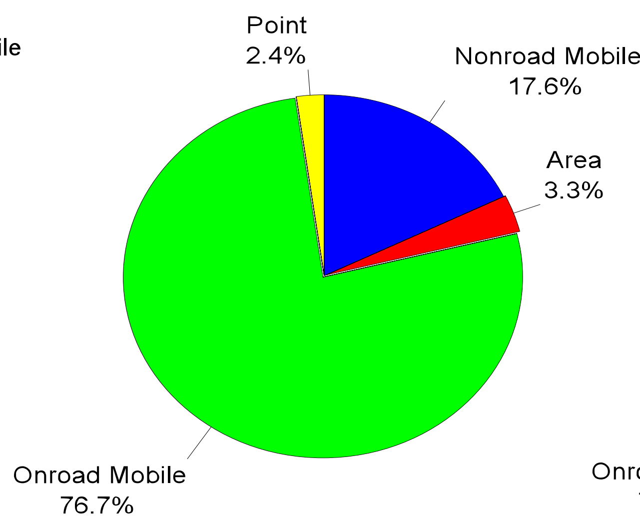
Table VII-6. 1994 base year, 2006 and 2015 committed maintenance measures inventory emission totals.

Friday, December 1994			Friday, December 2006			Friday, December 2015		
Source Category	Metric Tons per Day	Percent	Source Category	Metric Tons per Day	Percent	Source Category	Metric Tons per Day	Percent
Point	2.5	0.2	Point	21.9	2.4	Point	32.2	3.6
Area	21.0	2.0	Area	29.7	3.3	Area	36.2	4.0
Nonroad Mobile	155.1	14.8	Nonroad Mobile	161.0	17.6	Nonroad Mobile	169.9	18.9
Onroad Mobile	869.6	83.0	Onroad Mobile	699.7	76.7	Onroad Mobile	662.9	73.6
Total	1048.2*	100.0*	Total	912.3*	100.0*	Total	901.2*	100.0*

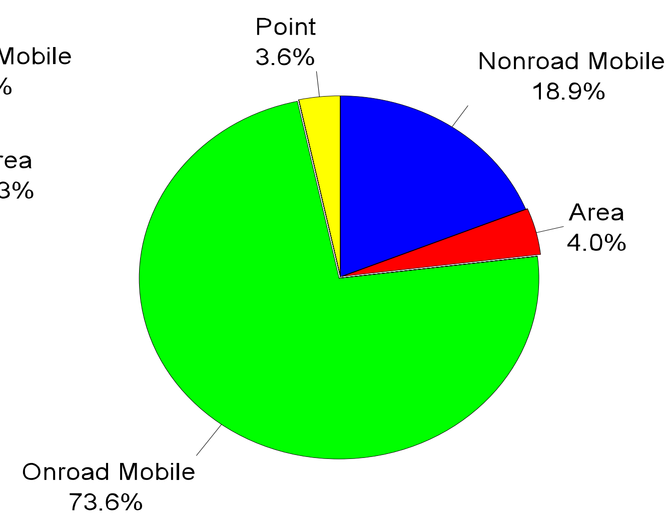
* Note that the sum of the source categories may not equal 100.0 percent due to rounding.



December 1994



December 2006



December 2015

Table VII-7. Major background CO emission sources (greater than one metric ton per day) in the modeling domain for a Friday in December 2006 and 2015.

SCC/ASC	Description	CO Emission Rate (metric tons/day) 2006	2015
2265004070	Commercial Turf Equipment - Gasoline (4 - stroke)	21.4	25.8
2265006005	Generator Sets <50 HP - Gasoline (4 - stroke)	25.3	25.3
2104008001	Fireplaces	16.5	19.9
2265004010	Lawn Mowers - Gasoline (4 - stroke)	17.3	14.9
2265004055	Lawn & Garden Tractors - Gasoline (4 - stroke)	11.8	11.7
2265003020	Forklifts - Gasoline (4 - stroke)	6.2	8.3
2103006000	Natural Gas Boilers	6.3	7.8
2265006025	Welders <50 HP - Gasoline (4 - stroke)	7.4	7.4
2265006010	Pumps <50 HP - Gasoline (4 - stroke)	6.5	6.5
2275020000	Aircraft - Air Carrier	3.9	4.6
2265006015	Air Compressors <50 HP - Gasoline (4 - stroke)	4.5	4.5
2265008010	Terminal Tractors - Gasoline (4 - stroke)	3.6	4.3
2275050000	Aircraft - General	4.4	3.5
2270002069	Crawler Tractors - Diesel	2.8	3.5
2260004010	Lawn Mowers - Gasoline (2 - stroke)	4.1	3.3
2260004025	Trimmers/Edgers/Brush Cutters - Gasoline (2 - stroke)	4.2	3.3
2285000000	Railroad Equipment	2.3	3.0
2265008005	Aircraft Support Equipment - Gasoline (4 - stroke)	2.3	2.7
2270002066	Tractors/Loaders/Backhoes - Diesel	2.1	2.4
2260003020	Forklifts - Gasoline (2 - stroke)	1.6	2.2
2265006030	Pressure Washers <50 HP - Gasoline (4 - stroke)	2.1	2.1
2270002060	Rubber Tired Loaders - Diesel	1.6	2.0
2610000000	Open Burning	1.7	1.7
2265002039	Concrete/Industrial Saws - Gasoline (4 - stroke)	1.3	1.7
2102004000	Industrial Internal Combustion - Distillate Oil Boiler	1.1	1.5
2104006000	Residential Internal Combustion - Natural Gas	1.1	1.4
2270002075	Off-Highway Tractors - Diesel	1.5	1.4
2265002021	Paving Equipment - Gasoline (4 - stroke)	1.0	1.4
2265002015	Construction Equipment - Rollers	0.8	1.1
2270002018	Construction Equipment - Scrapers	1.0	1.1
2265002030	Construction Equipment - Trenchers	0.8	1.1
2265003030	Industrial Equipment - Sweepers/Scrubbers	0.8	1.0
2260004020	Chain Saws < 6 HP	1.8	1.0
2260004030	Leafblowers/Vacuums(Residential)	1.2	1.0
2265004040	Rear Engine Riding Mowers(Residential)	1.0	1.0
Total Background Emissions*		212.6*	238.3*

*Total of all emission sources, including those which emit less one metric ton per day.

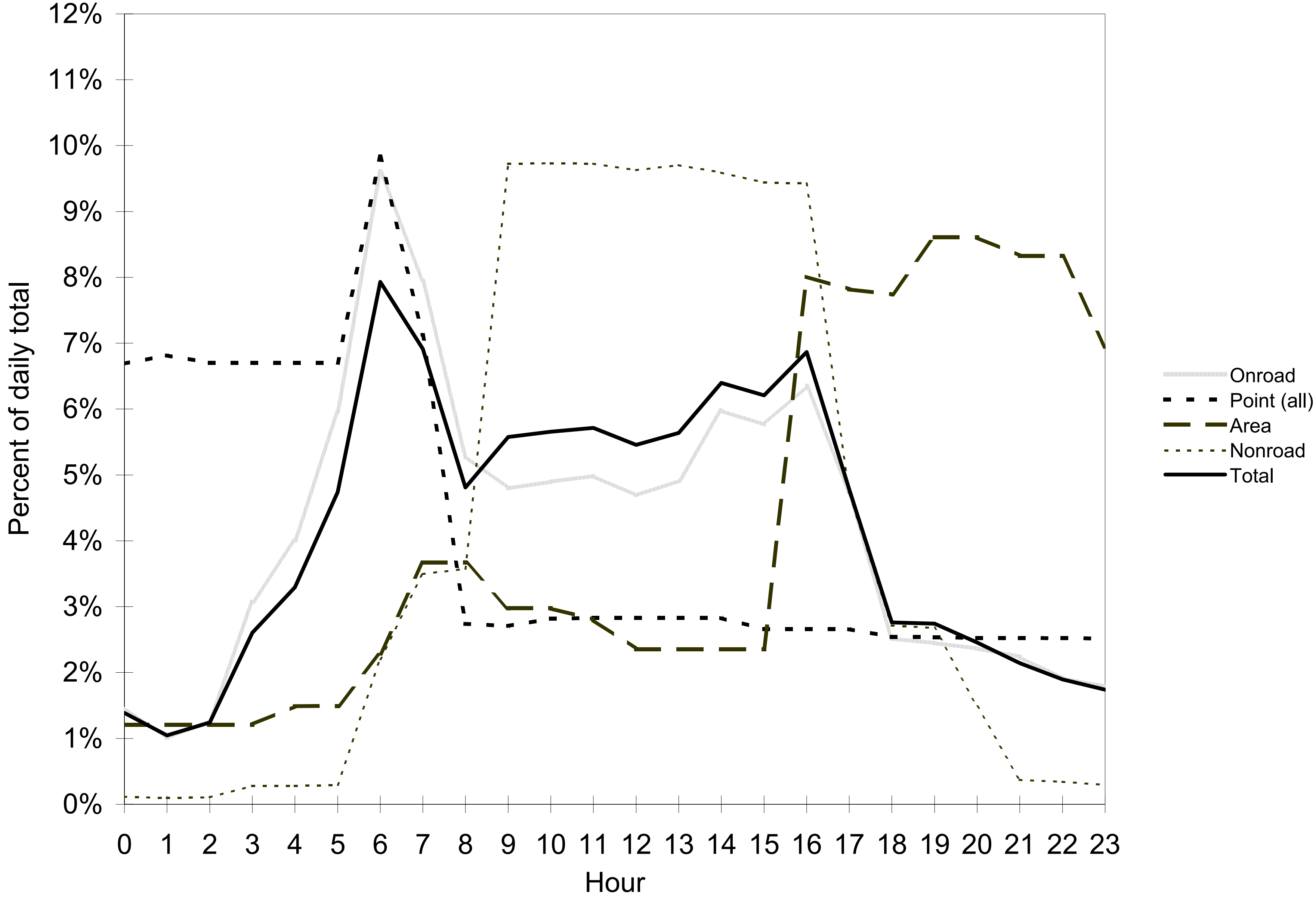


FIGURE VII-4. Temporal Distribution of Emission Sources, Friday in 2015.

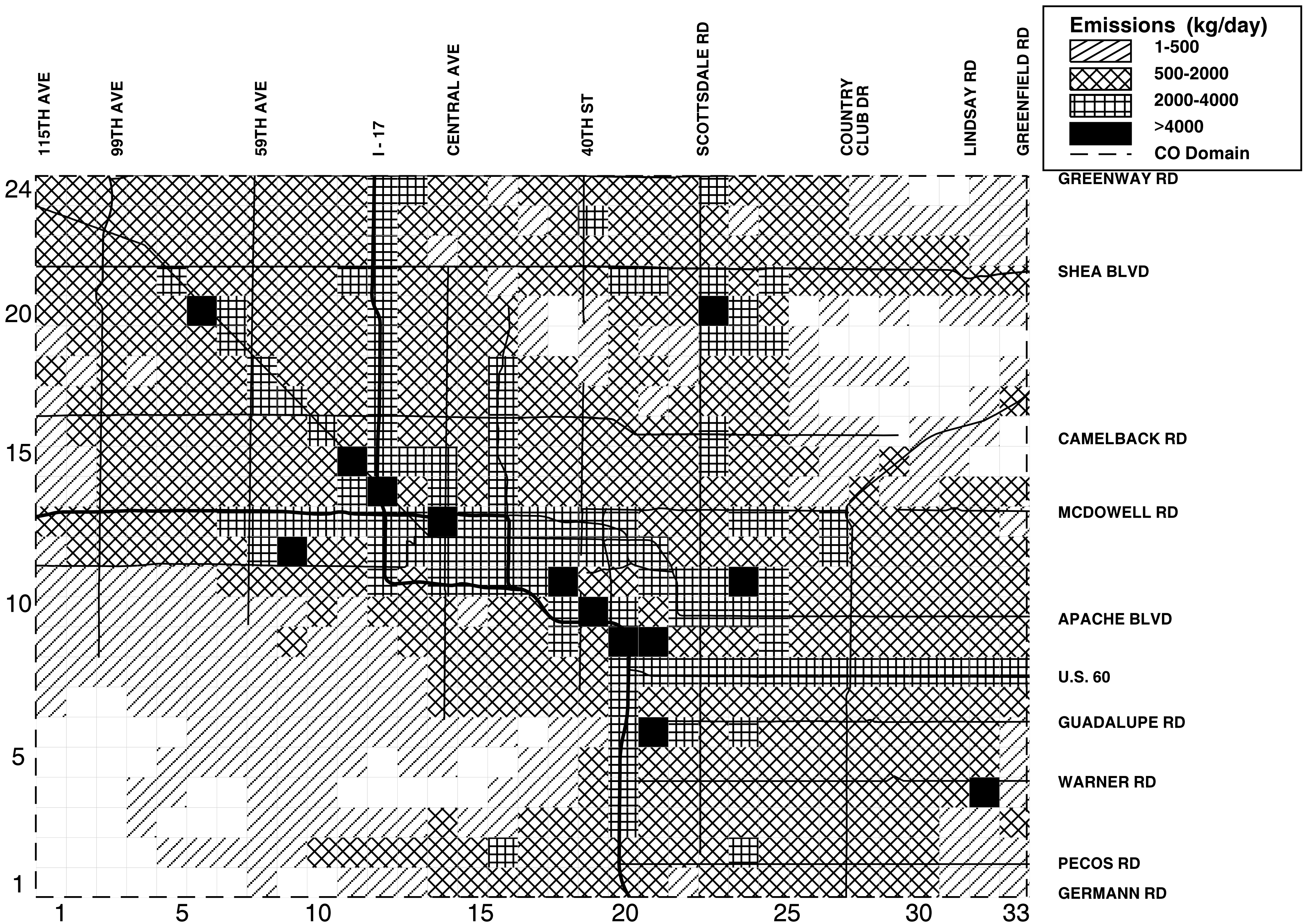


FIGURE VII-5. The spatial allocation of the total CO emission inventory with the committed maintenance measure package for a Friday in December 2015. Max. Value = 13,197 kg/day at (32,4). Total = 901,182 kg/day

Table VII-8(a). Emission totals for a Friday in December (metric tons/day).

Source	1994	2006	2015	1994-2006 Change (%)	1994-2015 Change (%)
Point	2.5	21.9	32.2	776.00	1188.00
Area	21.0	29.7	36.2	41.43	72.38
Nonroad Mobile	155.1	161.0	169.9	3.80	9.54
Onroad Mobile	869.6	699.7	662.9	-19.54	-23.77
Total	**1048.2**	**912.3**	**901.2**	**-12.97**	**-14.02**

Table VII-8(b). Emission totals for a Saturday in December (metric tons/day).

Source	1994	2006	2015	1994-2006 Change (%)	1994-2015 Change (%)
Point	2.5	21.3	31.5	752.00	1160.00
Area	21.3	27.7	35.3	30.05	65.73
Nonroad Mobile	207.7	203.1	208.1	-2.21	0.19
Onroad Mobile	538.1	494.7	398.0	-8.07	-26.04
Total	**769.6**	**746.8**	**672.9**	**-2.96**	**-12.56**

Table VII-9. Summary of the 1994, 2006, and 2015 maximum simulated carbon monoxide eight-hour concentrations for the December episode.

Base Year	Regional Maximum Simulated eight-hour Concentration (ppm)	Location
1994	10.71	(15,13)
2006	8.92	(14,13)
2015	8.06	(14,13)

The microscale analysis performed for the 2006 and 2015 committed maintenance measure package was performed with the same general overall methodology as for the 1994 base year analysis, described in Section V. In all cases, emission factors derived with the MOBILE6 model are input to the CAL3QHC model for the same intersections along with traffic volumes for the intersection. In all cases, CAL3QHC is run for each hour in the modeled time period and consecutive eight hours of results are combined to create eight hour concentrations.

The traffic data input to CAL3QHC represent average hourly conditions during the modeling period and were derived from a 2015 EMME/2 traffic assignment, which combined 2015 socioeconomic projections with 2015 highway and transit network data. A comparison of the daily modeled traffic through the intersections in 2006 versus 2015 was conducted. Since the total volumes were at capacity (level of service F) in both 2006 and 2015 at these microscale intersections, the 2015 traffic volumes were incorporated into the 2006 analysis.

VII-4-3. COMBINED UAM/CAL3HQC RESULTS

Table VII-10 summarizes the simulated maximum eight-hour average CO concentrations for all grid cells greater than nine ppm for 1994. Since the simulated CO concentrations for 2006 and 2015 are all below nine ppm, Table VII-10 does not include data for future years. The combined UAM and CAL3QHC results for 1994 show that concentrations greater than nine ppm were simulated at 11 grid cells, and a total areal exposure of 274.48 ppm-km^2 was calculated for grid cells above nine ppm. The results from UAM only for 1994 show that concentrations greater than nine ppm were simulated at 9 grid cells, and a total areal exposure of 224.63 ppm-km^2 was calculated for grid cells above nine ppm. The predicted 8-hour CO concentrations for 2006 and 2015 are all below nine ppm in all grid cells of the modeling domain. Therefore, the simulated total areal exposure to 9 ppm CO concentration in 2006 and 2015 is zero. Areal exposure, in this context, is defined as the sum over all exceedance grid cells of the simulated concentration multiplied by the grid cell area. Areal exposure is an integrated air quality measure that represents the overall change in simulated air quality, rather than the change in any single grid cell. The areal exposure decreases to zero in 2006 and 2015 from 1994.

The maximum CO modeled concentrations at the grid cells where the receptors for the hot spots were located for the 1994, 2006, and 2015 model years are summarized in Table VII-11. As discussed previously, the combined maximum CO eight-hour concentration decreases from 1994 to 2006 and 2015. The simulations showed that the CO eight-hour concentrations are below 9 ppm everywhere in the modeling domain in both 2006 and 2015 years. The status of maintaining the carbon monoxide eight-hour NAAQS for 2006 and 2015 has been demonstrated by the modeling exercises.

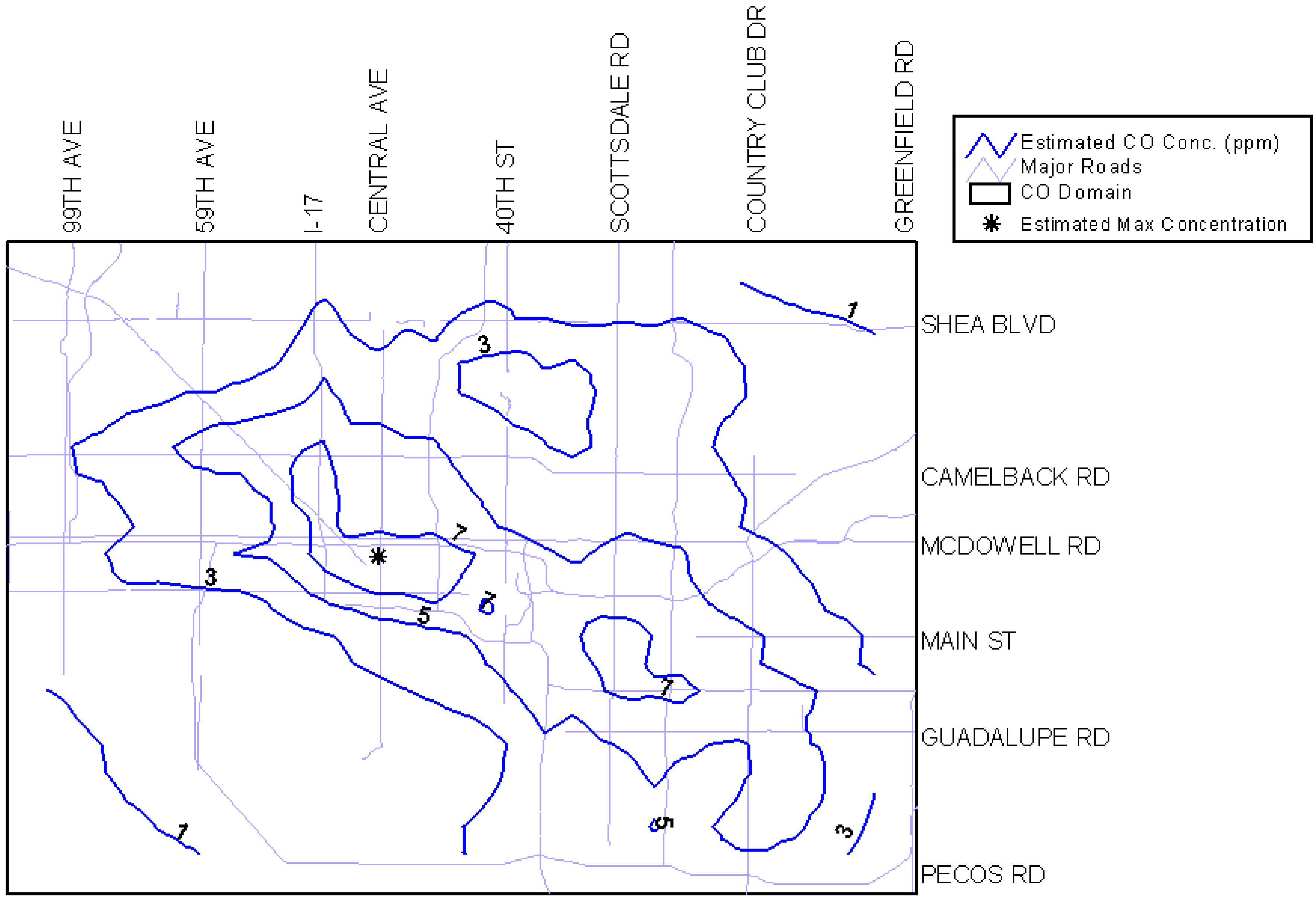


Figure VII-6(a) Isopleth plot illustrating the 2006 daily maximum simulated carbon monoxide eight-hour concentrations for the episode (without microscale components, max conc = 8.92 ppm at (14,13)).

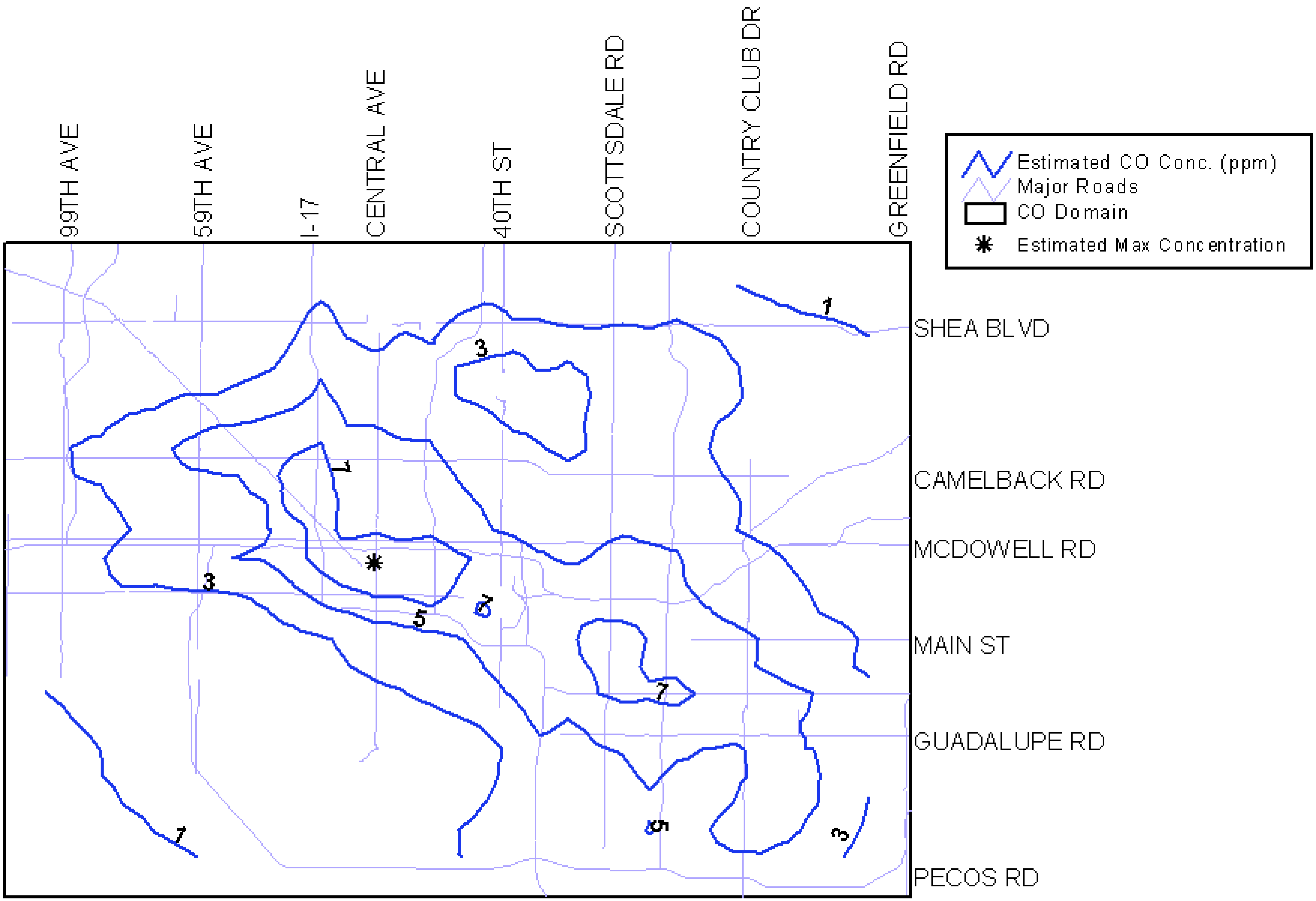


Figure VII-6(b) Isopleth plot illustrating the 2006 daily maximum simulated carbon monoxide eight-hour concentrations for the episode (with microscale components, max conc = 8.92 ppm at (14.13)).

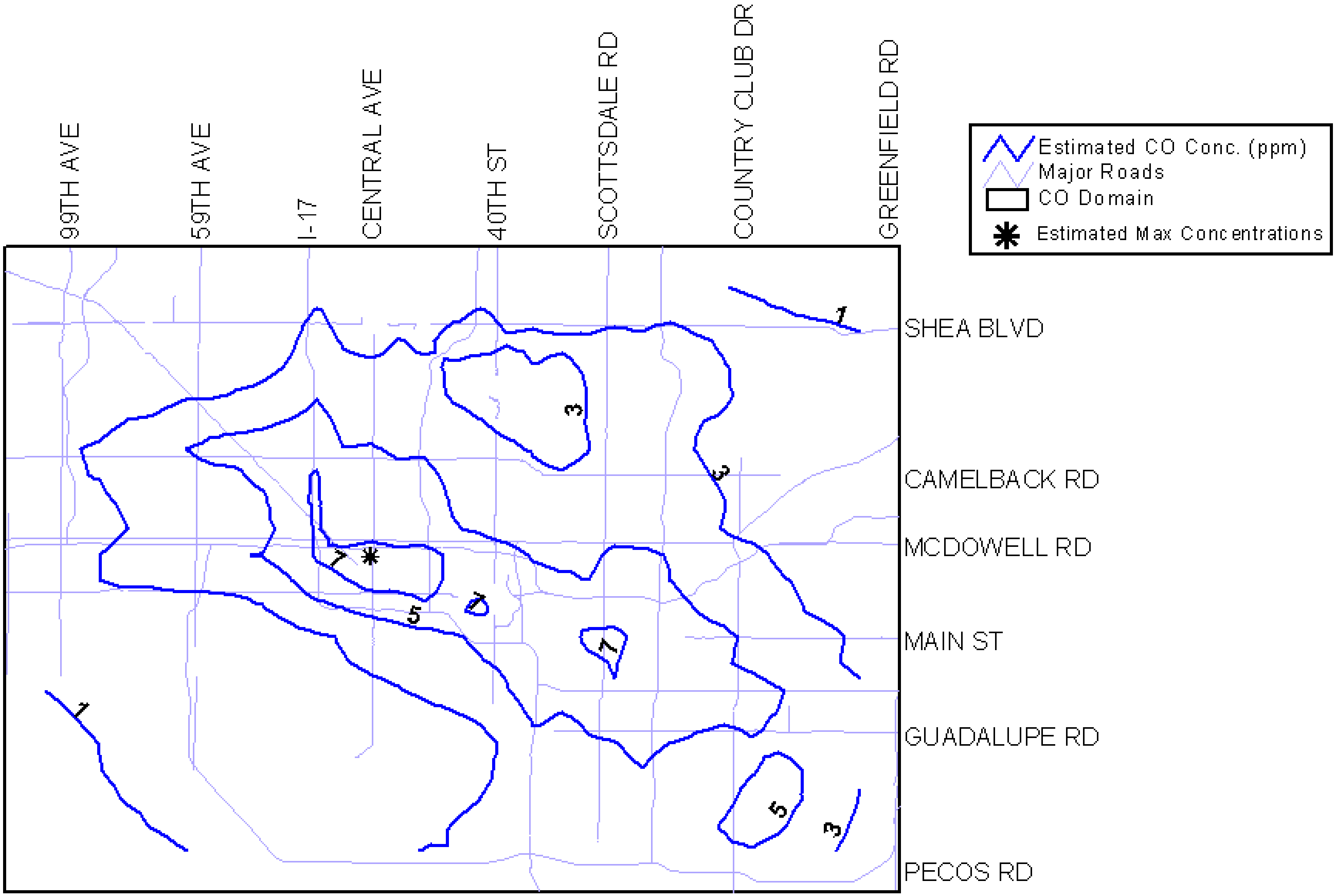


Figure VII-7(a) Isopleth plot illustrating the 2015 daily maximum simulated carbon monoxide eight-hour concentrations for the episode (without microscale components, max conc = 8.06 ppm at (14,13)).

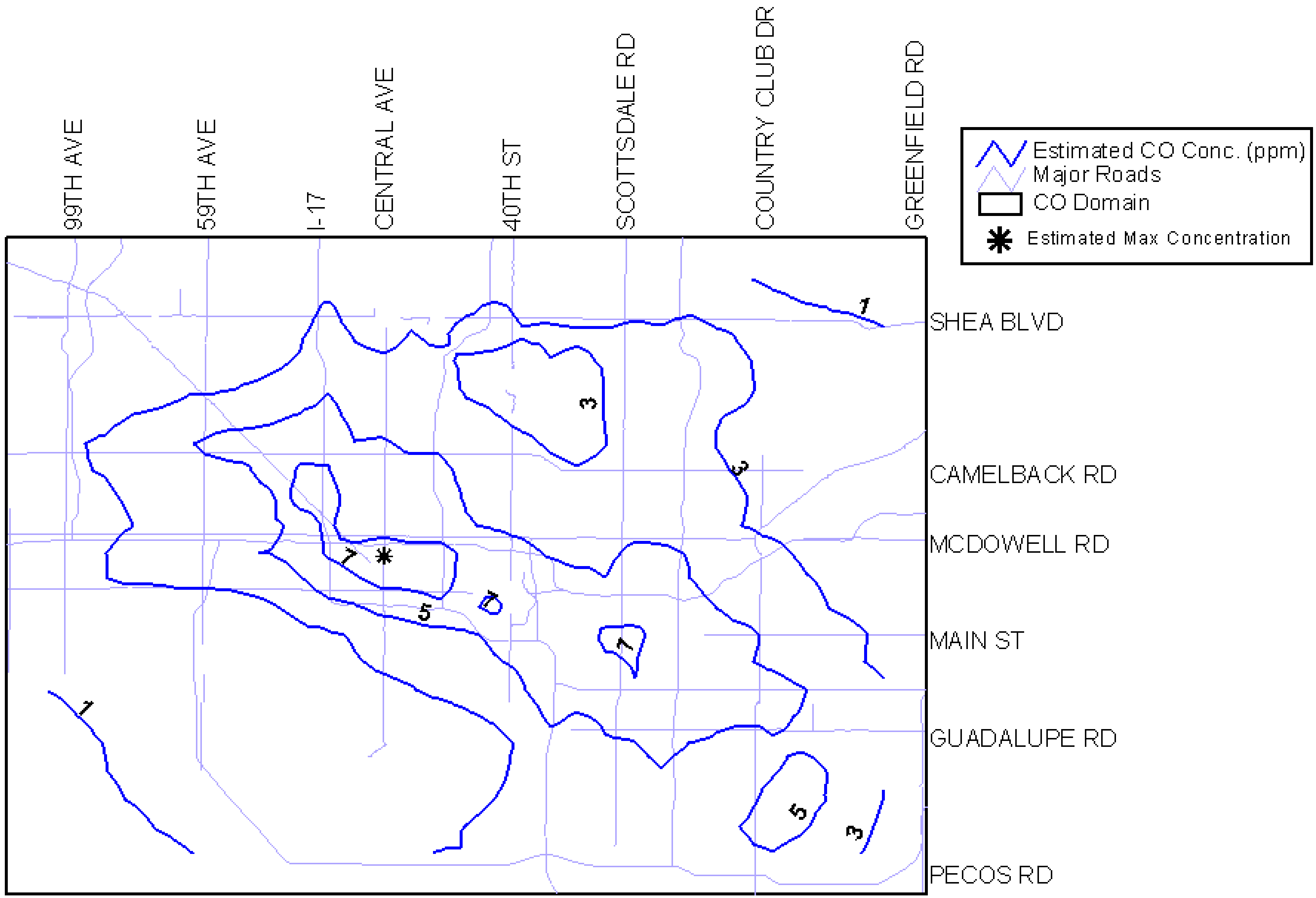


Figure VII-7(b) Isopleth plot illustrating the 2015 daily maximum simulated carbon monoxide eight-hour concentrations for the episode (with microscale components, max conc = 8.06 ppm at (14,13)).

Table VII-10. Summary of the simulated maximum eight-hour average CO concentrations for all grid cells greater than 9.0 ppm for 1994. Since no grid cell in the modeling domain shows CO concentration greater than 9.0 ppm for 2006 and 2015, the 2006 and 2015 data are not listed.

Grid Cell	CO Concentrations (ppm)	
	1994	
	UAM+CAL3QHC	UAM Only
(12,17)	9.07	9.07
(12,16)	9.33	9.33
(12,15)	9.51	-
(12,14)	9.75	-
(13,13)	9.70	9.70
(14,13)	10.26	10.26
(15,13)	10.71	10.71
(16,13)	10.11	10.11
(17,13)	9.19	9.19
(22,10)	9.22	9.22
(23,8)	9.18	9.18
Areal Exposure ($ppm*km^2$)	274.48	224.63

Table VII-11. Combined UAM/CAL3QHC maximum eight-hour concentrations (ppm) in the Maricopa County area for the December 16-17, 1994 base case with emissions projected to a 2006 and 2015 committed maintenance measures package scenario.

Location	UAM Grid Cell	UAM Concentration	CAL3QHC Concentration	Total	Ending Hour
		For 2006			
WISR Monitor	(11,15)	7.22	0.06	7.28	0400
WISR Receptor # 9	(11,15)	7.17	1.08	8.25	0300
WISR Receptor # 8	(11,15)	7.17	0.91	8.08	0300
WISR Receptor # 20	(11,15)	7.17	0.68	7.85	0300
PHGA Monitor *	N/A	N/A	N/A	0.00	N/A
PHGA Receptor # 30	(12,15)	7.74	0.50	8.24	0300
PHGA Receptor # 46	(12,14)	7.89	0.19	8.08	0300
PHGA Receptor # 29	(12,15)	7.74	0.29	8.03	0300
UAM Maximum	(14,13)	8.92	-	8.92	0400
		For 2015			
WISR Monitor	(11,15)	6.56	0.03	6.59	0300
WISR Receptor # 9	(11,15)	6.23	1.81	8.04	0200
WISR Receptor # 8	(11,15)	6.23	1.61	7.84	0200
WISR Receptor # 20	(11,15)	6.56	0.88	7.44	0300
PHGA Monitor *	N/A	N/A	N/A	0.00	N/A
PHGA Receptor # 30	(12,15)	7.16	0.65	7.81	0300
PHGA Receptor # 29	(12,15)	7.16	0.29	7.45	0300
PHGA Receptor # 46	(12,14)	7.19	0.20	7.39	0300
UAM Maximum	(14,13)	8.06	-	8.06	0400

* Due to the reconfiguration of the PHGA intersection, the location of the actual monitor at that intersection in future years, if any, is unknown.

VII-4-4. MODELING RELIABILITY AND UNCERTAINTIES

The Urban Airshed Model (UAM) has been identified as an effective tool for evaluating emission control and projecting future air quality effects of emission changes. However, future year modeling results should not be considered absolute guarantees of future air quality. Uncertainties in the models used and their inputs, along with meteorological variability, may result in actual future air quality that differs from predicted air quality. Higher concentrations than those modeled may occur for any of the following reasons:

- Meteorological variability - In selecting a modeling episode, the goal is to select periods that represent worst-case conditions. If episodes with more severe stagnation occur in the future, emission controls designed to reach maintenance for a historical episode may not be adequate.

- Emissions variability - Emission estimates are based on average source usage, taking into account seasonal, diurnal, and day-of-week factors. Onroad mobile emissions take into account day-specific temperatures as well. However, emissions on a given day may be greater than average due to greater than average usage, lower temperatures, or other factors.

- Uncertainty in growth projections - If growth projections underestimate true growth rates, future year emissions may be greater than projected emissions.

- Uncertainty in control measure effectiveness - If actual emission reductions from a given control measure are smaller than the estimated emission reductions, future year concentrations may be greater than modeled concentrations.

- Model performance - If the model under predicted concentrations at a particular site, or failed to capture a particular aspect of the meteorology, then a level of emission reduction that appeared to be adequate during modeling may not actually be adequate.

By similar reasoning, future measured concentrations may be lower than modeled concentrations because of these variabilities and uncertainties.

As a result, although for regulatory purposes a modeled peak carbon monoxide eight-hour concentration of 8.99 ppm is adequate to demonstrate maintenance, modeling results are better thought of as a point on a probability distribution. If the modeled peak value is far below nine ppm, the probability that maintenance will result, even under differing conditions, is high. If the modeled peak is very close to nine ppm, however, the probability that maintenance will result may not be significantly different from about 50 percent. If the modeled peak concentration is greater than nine ppm, there remains some probability that maintenance will result, but random weather events will likely be the determining factor.

VII-5. Contingency Plan

Section 175A(d) of the Clean Air Act requires that maintenance plans contain contingency provisions. EPA guidance on the required content of the contingency plan is provided in the September 4, 1992 EPA memorandum [22]. This memo indicates that the contingency plan is not required to contain fully adopted contingency measures. However, the plan should contain clearly identified contingency measures to be adopted, a schedule and procedure for adoption and implementation, and a specific time limit for action by the State. In addition, specific indicators should be identified which will be used to determine when the contingency measures need to be implemented. The Maintenance Plan addresses each of these requirements for an approvable contingency plan.

Consistent with the August 13, 1993 EPA guidance memorandum [24], the contingency plan described in this technical support document is comprised of committed control measures that are expected to be implemented early. Early implementation of contingency measures in a maintenance plan has been approved by EPA in the redesignation of the Salt Lake City Carbon Monoxide Nonattainment Area to attainment (see page 3216 of the January 21, 1999 Federal Register). In that action, EPA noted that both contingency measures in the Salt Lake City contingency plan had already been partially implemented.

The three contingency measures in the Maintenance Plan are Area A Expansion, Gross Emitter Waivers Provision, and Increased Waiver Repair Limit. Emissions reduction credit for these contingency measures was not taken in the maintenance demonstration.

A description of these individual measures is provided in Section VII-2-2. Figure VII-2 provides the emission reductions in 2000 for the individual contingency measures. Early implementation of these contingency measures provides additional confidence that the CO standard will be maintained through 2015.

The success of an air quality program is measured by the concentrations recorded at the monitors. In order to ensure that violations of the CO standard do not occur in the future, ambient air quality monitoring data will be examined to determine if additional contingency measures are needed. Two verified readings exceeding 9.0 ppm at two or more SLAMS or NAMS monitors during a single CO season (i.e. October 1 through March 31) will trigger consideration of additional measures, which may include strengthening of the contingency measures shown in Figure VII-2. Since a violation of the NAAQS for eight-hour carbon monoxide occurs when the second highest reading at the same monitor over two consecutive years is greater than or equal to 9.5 ppm, this trigger is more stringent than the standard and will serve to prevent the occurrence of future violations. When the trigger is activated, additional measures would be considered for adoption on the following schedule:

(A) verification of the monitoring data to be completed three months after activation of the trigger; (B) applicable measure to be considered for adoption six months after date established in A above; and (C) resultant committed measure to be implemented within six to twelve months, depending upon the time needed to put the measure in place.

VII-6. Motor Vehicle Emissions Budget for Conformity

In accordance with the 1990 Clean Air Act Amendments, conformity requirements are intended to ensure that transportation activities do not result in air quality degradation. Section 176 of the Amendments requires that transportation plans, programs, and projects conform to applicable air quality plans before the transportation action is approved by a Metropolitan Planning Organization (MPO). The designated MPO for the Maricopa County area is MAG.

Section 176(c) of CAAA provides the framework for ensuring that Federal actions conform to air quality plans under section 110. Conformity to an implementation plan means that proposed activities must not (1) cause or contribute to any new violation of any standard in any area, (2) increase the frequency or severity of any existing violation of any standard in any area, or (3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

EPA transportation conformity regulations [31] establish criteria involving comparison of projected transportation plan emissions with the motor vehicle emissions assumed in applicable air quality plans. The regulations define the term "motor vehicle emissions budget" as meaning "the portion of the total allowable emissions defined in a revision of the applicable implementation plan (or in an implementation plan revision which was endorsed by the Governor or his or her designee) for a certain date for the purpose of meeting reasonable further progress milestones or attainment or maintenance demonstrations, for any criteria pollutant or its precursors, allocated by the applicable implementation plan to highway and transit vehicles."

The transportation conformity budget for carbon monoxide was established in Chapter Nine of the Revised Serious Area CO Plan in the section, Motor Vehicle Emissions Budget for Conformity. The budget was established at 412.2 metric tons per day for 2000 for the modeled area. EPA issued a notice of adequacy in the *Federal Register* on October 17, 2001, finding that this budget was adequate for transportation conformity purposes. This budget will be used in MAG transportation conformity analyses until the maintenance plan is approved or the maintenance budgets are found to be adequate. At that time, new transportation conformity budgets for carbon monoxide will be established for 2006 and 2015 for use in subsequent conformity analyses.

The projections in this Maintenance Plan indicate that the daily carbon monoxide emissions in 2006 and 2015 would be 912.3 and 901.2 metric tons per day, respectively, with the committed maintenance measures, which includes an onroad mobile source contribution of 699.7 metric tons per day in 2006 and 662.9 metric tons per day in 2015 (from Table VII-6). The total onroad mobile source emissions of 662.9 metric tons per day represents the motor vehicle emissions conformity budget for carbon monoxide in 2015. Since 2006 was also modeled, the Maintenance Plan establishes an interim motor vehicle emissions conformity budget for carbon monoxide of 699.7 metric tons per day in 2006. The 2006 and 2015 emissions inventories used to establish the mobile source emissions budgets are documented in Appendix VII.

After EPA finds the maintenance budget to be adequate or approves the maintenance plan, MAG will apply the provisions of the EPA transportation conformity regulations (August 15, 1997), 40 CFR Part 93 Section 93.118(b). Chapter Three of the CO Maintenance Plan establishes a motor vehicle emissions budget for 2015 and the interim year of 2006. In accordance with 40 CFR Part 93 Section 93.118(b), MAG will use the new interim mobile source carbon monoxide emissions budget for the conformity horizon years of 2006 through 2014 and the new 2015 mobile source carbon monoxide emissions budget for conformity horizon years after 2014.

Onroad mobile source emissions for 2006 and 2015 were developed by MAG using the EPA-approved MOBILE6 model and Highway Performance Monitoring System (HPMS) reconciliation methodology. Documentation of the HPMS reconciliation methodology and an EPA approval letter are contained in Appendix III-iv. After the new 2006 and 2015 motor vehicle emissions budgets are found to be adequate or are approved by EPA for conformity purposes, MAG will apply MOBILE6 and the HPMS reconciliation procedure to estimate onroad mobile source emissions for the conformity horizon years of 2006 and beyond.

VII-7. Conclusions

As discussed above, the UAM simulations, with and without the CAL3QHC hot-spot results and incorporating the committed maintenance control measures, demonstrate maintenance of the carbon monoxide standard through 2015. Based on UAM and the microscale modeling, the peak CO concentration is estimated to be less than 9.0 ppm in 2006 and 2015. It is important to note that the measures discussed in Section VII are legally enforceable commitments that will continue to provide air-quality benefits beyond the maintenance date. The strength and level of commitments provided by State, County and local governments, combined with no monitored violations of the carbon monoxide standard since 1996, provide confidence in the maintenance demonstration and the prospect for continued clean air in the future.

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APPENDICES

APPENDIX I

PROTOCOL AND DATA FILE LIST

Appendix I-i

DRAFT PROTOCOL DOCUMENT FOR URBAN AIRSHED MODELING OF CARBON MONOXIDE FOR THE MARICOPA COUNTY NONATTAINMENT AREA, IN SUPPORT OF A CARBON MONOXIDE MAINTENANCE PLAN

DRAFT

PROTOCOL DOCUMENT FOR URBAN AIRSHED MODELING OF CARBON MONOXIDE FOR THE MARICOPA COUNTY NONATTAINMENT AREA, IN SUPPORT OF A CARBON MONOXIDE MAINTENANCE PLAN

Maricopa Association of Governments
April 2002

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Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AIRS	Aerometric Information Retrieval System
AZMET	Arizona Meteorological Network
CAAA	Clean Air Act Amendments of 1990
DWM	UAM Diagnostic Wind Model
EPA	U. S. Environmental Protection Agency
EPS2.0	UAM Emissions Preprocessor System version 2.0
GIS	Geographic Information System
I/M	Inspection and Maintenance
MAG	Maricopa Association of Governments
MCESD	Maricopa County Environmental Services Department
MCFCD	Maricopa County Flood Control Department
MIXEMUP	Mixing-height Estimation Methodology for UAM Purposes
NAAQS	National Ambient Air Quality Standards
NWS	National Weather Service
PRISMS	Phoenix Realtime Instrumentation for Surface Meteorological Studies
RVP	Reid Vapor Pressure
SIP	State Implementation Plan
UAM	Urban Airshed Model

1. COMPUTER MODELING STUDY DESIGN

1.1 Background

In 1974, the U.S. Environmental Protection Agency (EPA) formally designated part of the MAG region as not being in attainment of the national ambient air quality standard (NAAQS) for carbon monoxide (CO). The CO nonattainment area encompasses approximately 1,962 square miles, or approximately 22 percent of the Maricopa County land area.

EPA reclassified the Maricopa County nonattainment area from Moderate to Serious for carbon monoxide, effective August 28, 1996. The region is required to meet the national air quality standards as expeditiously as practicable, but no later than the deadlines set forth in the Clean Air Act Amendments (CAAA). The attainment date specified by the CAAA is December 31, 2000 for serious CO nonattainment areas. The MAG 1999 Serious Area CO Plan was submitted to EPA in July 1999. In 2000, the Arizona legislature repealed the Remote Sensing Program. A revised Serious Area CO Plan [10] demonstrating attainment of the CO NAAQS by December 31, 2000 without the Remote Sensing Program was submitted to EPA in March 2001.

In addition to an approved implementation plan, a CO maintenance plan is one of several requirements necessary for EPA to redesignate the Maricopa County nonattainment area to attainment. As the designated regional air quality planning agency, the Maricopa Association of Governments (MAG) conducts the emissions and concentration modeling, as well as prepares the air quality plans. MAG has developed this protocol to provide a guide to the performance and successful completion of the CO air quality modeling analysis for the Maricopa County nonattainment area. This modeling is being performed as a maintenance demonstration which will be submitted to EPA with the CO Maintenance Plan.

The primary requirement of the CO maintenance plan is to demonstrate that the 8-hour CO standard will be maintained for at least ten years after the area is officially redesignated to attainment by EPA. In determining the amount of lead time to allow, EPA indicated that 18 months, as granted in section 107(d)(3)(D) of the Clean Air Act Amendments, should be assumed for EPA to approve a redesignation request [2]. Due to uncertainties regarding when the area will be redesignated to attainment, the year 2015 will be modeled to assure that the 8-hour CO NAAQS is maintained at least ten years after an official notice of redesignation to attainment by the EPA.

On January 29, 2002, EPA announced the official release of the MOBILE6 model and triggered the two-year grace period for local agencies to utilize MOBILE6 in SIP revisions and transportation conformity analyses. In order to provide a 2006 budget of onroad mobile source emissions for conformity purposes, the year 2006 will also be modeled and included in the maintenance plan.

The purpose of this protocol is to describe the methodologies to be followed throughout the analysis. This model application protocol, which contains the information recommended in the EPA Guideline [4], describes the technical approach that will be used to determine if the 8-hour CO NAAQS in the Maricopa County area will be maintained through 2015. It should be viewed as a set of general guidelines that provide focus, consistency, and a basis for consensus for all parties involved in the analysis. Procedures described in this protocol are intended to satisfy the CAAA maintenance demonstration requirements for the nonattainment area and to foster confidence in the modeling study.

The protocol will be reviewed and approved by all participants at the beginning of the analysis.

1.2 Core Air Quality Model

The Urban Airshed Model version IV (UAM-IV) was recommended by EPA for urban areawide CO analyses [24]. In the EPA proposed rule for Guideline on Air Quality Models, EPA required that an Eulerian grid model be used in urban areawide analyses of CO [25]. Because UAM-IV is an Eulerian grid model and accounts for spatial and temporal variations, it is well suited for evaluating future air quality and the effects of potential emission control strategies on urban air quality.

Performance evaluation of the UAM CO modeling effort will be accomplished by replicating a historical CO episode. Model inputs will be prepared from available meteorological, emissions, air quality, and land use data for selected episode days defined in a later section of this document. The model will be then exercised with these inputs and the results will be evaluated to determine model performance. Once the model results are evaluated and the model performs within levels prescribed in the Guidance [4], a projected emission inventory will be prepared to represent future emission scenarios. The model will simulate carbon monoxide concentrations for the future year to infer the impact of the emission changes for a particular set of meteorological conditions. This information will be used to predict attainment of the 8-hour CO NAAQS. In this modeling effort, a 2015 modeling year inventory with the committed measures documented in the Serious Area CO Plan will be developed and modeled to predict if maintenance of the CO NAAQS occurs in 2015. 2006 will also be modeled to provide an onroad mobile source budget for conformity purposes.

1.3 Preprocessor Programs

UAM-IV assigns emissions by grid square within the specified modeling grid. The user may specify the output interval (e.g., every one hour) for which average concentrations are calculated. At each time step, the model calculates CO concentrations in all grid cells. For this analysis, the 8-hour average concentrations for carbon monoxide will be calculated from the hourly concentrations output from UAM.

Figure 1.1 depicts the MAG air quality modeling chain. Most of the UAM input files will be prepared using the standard UAM preprocessor programs following the EPA Guidlane [4]. The input files containing information on air quality and meteorology will be based on measured data where available. The mixing depths will be calculated using the Mixing-Height Estimation Methodology for UAM Purpose (MIXEMUP) [13] procedure. The wind fields will be generated using the Diagnostic Wind Model (DWM) [7] which is included in the UAM program package. The UAM Emissions Preprocessor System (EPS2.0) [8] will be used to process the emissions inventories where the onroad mobile emissions will be generated by the EPA MOBILE6 model and M6Link. M6Link is a MAG software program applied at the transportation link level to generate gridded mobile source emissions for input to UAM. The EPA recommended CAL3QHC will be used for analyzing CO impacts at roadway intersections. More detailed discussions on the preparation of emission inventory, wind field specification, and mixing depths will be provided later in this protocol.

1.4 Analysis Objectives

Key objectives to be accomplished in this protocol document are the following:

1. enhance technical credibility,
2. encourage the participation of all interested parties,
3. lay out responsibilities of all participants,
4. provide for consensus building among all interested parties concerning modeling issues, and
5. provide documentation for technical decisions made in applying the model as well as the procedures followed in reaching these decisions.

The protocol details and formalizes procedures for conducting all phases of the modeling study such as:

1. stating the background, objectives, tentative schedule, and organizational structure for the study,
2. developing the necessary input data bases,
3. conducting quality assurance and diagnostic model analyses,
4. conducting model performance evaluations and interpreting modeling results, and

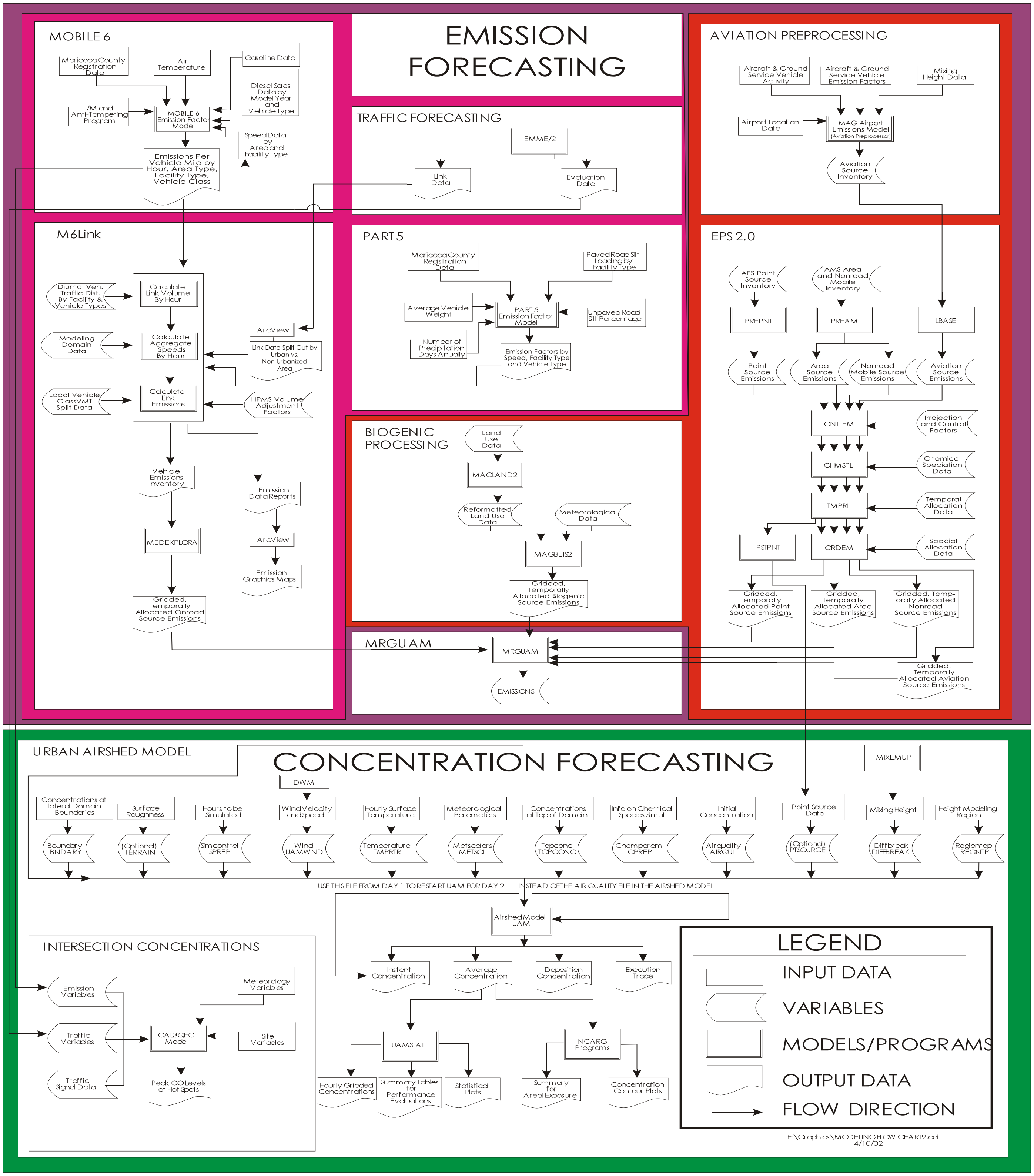

Figure 1.1.MAG air quality modeling chain.

5. describing procedures for using the model to demonstrate whether adopted control strategies are sufficient to demonstrate maintenance of the 8-hour carbon monoxide standard.

The 2006 and 2015 future year emission inventories will include the committed measures where appropriate from the Addendum to the MAG 1993 Moderate Area Ozone Plan [9], Revised MAG 1999 Serious Area Carbon Monoxide Plan [10], and Revised MAG 1999 Serious Area Particulate Plan for PM-10 [11], to determine if the current committed measures are sufficient to demonstrate maintenance of the standard. If the modeling effort outlined in this protocol does not demonstrate maintenance of the standard with the existing committed control measures, the technical support document will include documentation of additional activities that will be necessary to maintain the standard (i.e. establishing reduction goals, evaluating additional control measures, etc.).

1.5 Schedules

The CO air quality analysis for the Maricopa County Nonattainment area will be comprised of the following tasks:

1. Prepare a protocol document (this document) that describes the purpose, background, analysis objectives, and the procedures to be followed in the remainder of the analysis. This document also specifies the modeling domain and recommends a primary modeling episode. (TARGET DATE: second month)

2. The CO emission inventory reported in "*1993 Periodic Carbon Monoxide Emission Inventory*" [23] will be input into the Emission Preprocessor System 2.0 which will reformat the data into the appropriate UAM input files for the 1994 episode. (TARGET DATE: third month)

3. Conduct mobile source emissions modeling using MOBILE6 and M6link. (TARGET DATE: third month)

4. Develop meteorological and air quality UAM inputs for the 1994 episode. (TARGET DATE: third month)

5. Run UAM and evaluate model performance for the 1994 base case episode period. (TARGET DATE: third month)

6. Develop emission inventories for both 2006 and 2015 years. (TARGET DATE: fourth month)

7. Perform UAM simulations for 2006 and 2015 years. (TARGET DATE: fourth month)

8. Complete maintenance demonstration and write a technical support document (TSD) summarizing the analysis. (TARGET DATE: fifth month)

9. Submit the plan for external review. (TARGET DATE: sixth month)

10. Complete final revisions to the plan. (TARGET DATE: seventh month)

11. Submit the plan to ADEQ/EPA. (TARGET DATE: eighth month)

The schedule for these tasks is presented graphically in Figure 1.2.

1.6 Management Structure/Technical Committees

Technical oversight for this project will be provided by the Regional Air Quality Planning Team. This team includes staff representatives from the Maricopa Association of Governments (MAG), the Arizona Department of Environmental Quality (ADEQ), the Arizona Department of Transportation (ADOT), and the Maricopa County Environmental Services Department (MCESD). The activities of this working group are directed by a Memorandum of Agreement among the ADEQ, ADOT, MCESD, and MAG (see Attachment I). Representatives of other agencies, including EPA and the U.S. Department of Transportation, will be consulted in technical matters as needed. The Air Quality Planning Team will meet as needed during the CO modeling effort. Periodic reports on the status and progress of various phases of the modeling work will be presented at these meetings, and technical issues will be discussed and resolved.

MAG has responsibilities for regional involvement in a number of planning issues, and has established an extensive mechanism for ensuring coordinated policy direction from elected officials, coordinated management and technical input, advice from the appropriate agency staff, as well as direct citizen input. Figure 1.3 displays the MAG Policy Structure and Figure 1.4 shows the MAG Committee Structure. All policy committees and formal technical committees follow the Arizona open meeting law which requires, among other things, the posting of meeting notices and agendas at least 24 hours prior to any meeting.

<u>Public Input</u>

The MAG Regional Council is the governing body of MAG. It is comprised of elected officials from each member agency, two ex-officio members representing the Arizona State Transportation Board, and a representative from the Citizens Transportation Oversight Committee. This composition of elected officials is a reflection of citizen input at the local government level. The MAG Regional Council agenda includes a call to the audience, providing the opportunity for public comments at each monthly meeting.

MAG holds at least one formal public meeting prior to the adoption of any update to the

CO Modeling Task List	Month 1st	2nd	3rd	4th	5th	6th	7th	8th
Prepare protocol document		☆						
Base year EI preparation			☆					
MOBILE 6 modeling for onroad mobile emissions			☆					
Meteorological and air quality UAM inputs preparation			☆					
UAM modeling and base case performance evaluation			☆					
Develop EI for 2006 and 2015				☆				
UAM simulations for 2006 and 2015				☆				
Complete maintenance demonstration and write TSD					☆			
External review						☆		
Final revisions							☆	
Submit to ADEQ/EPA								☆

Figure 1.2. Tasks and target time schedule of the CO air quality analysis for the Maricopa County nonattainment area.

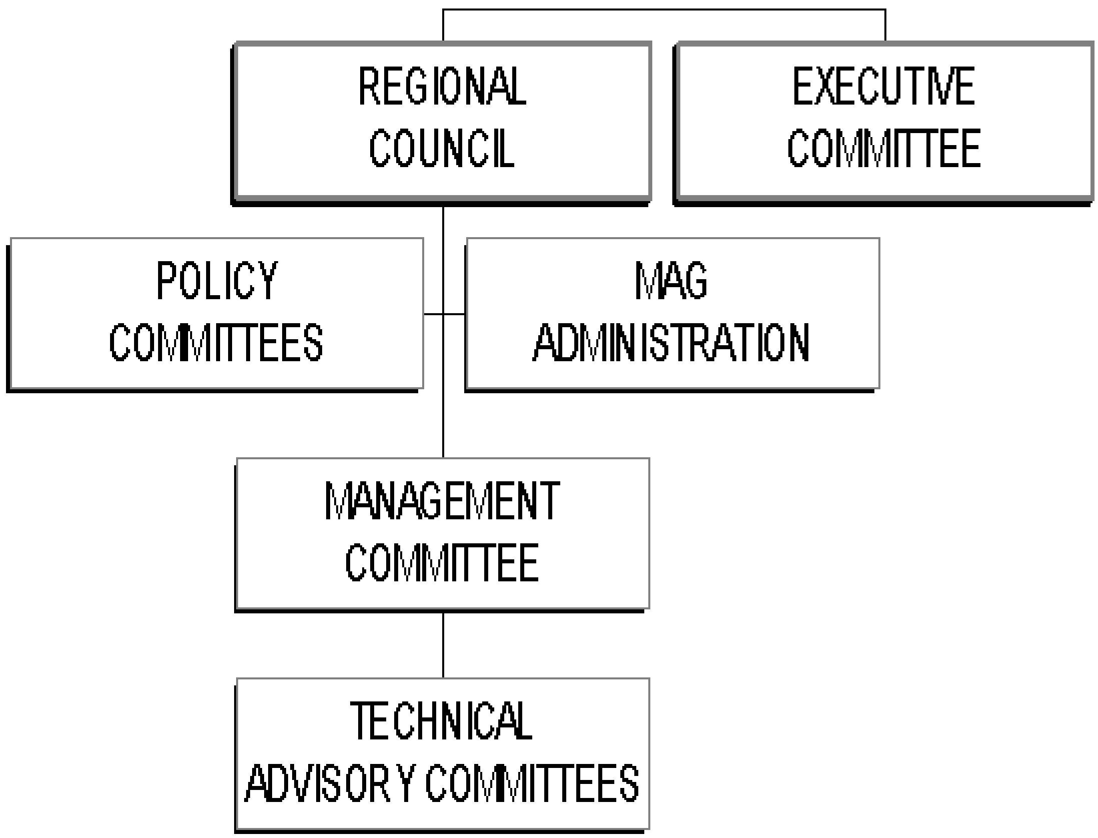

Figure 1.3. MAG policy structure.

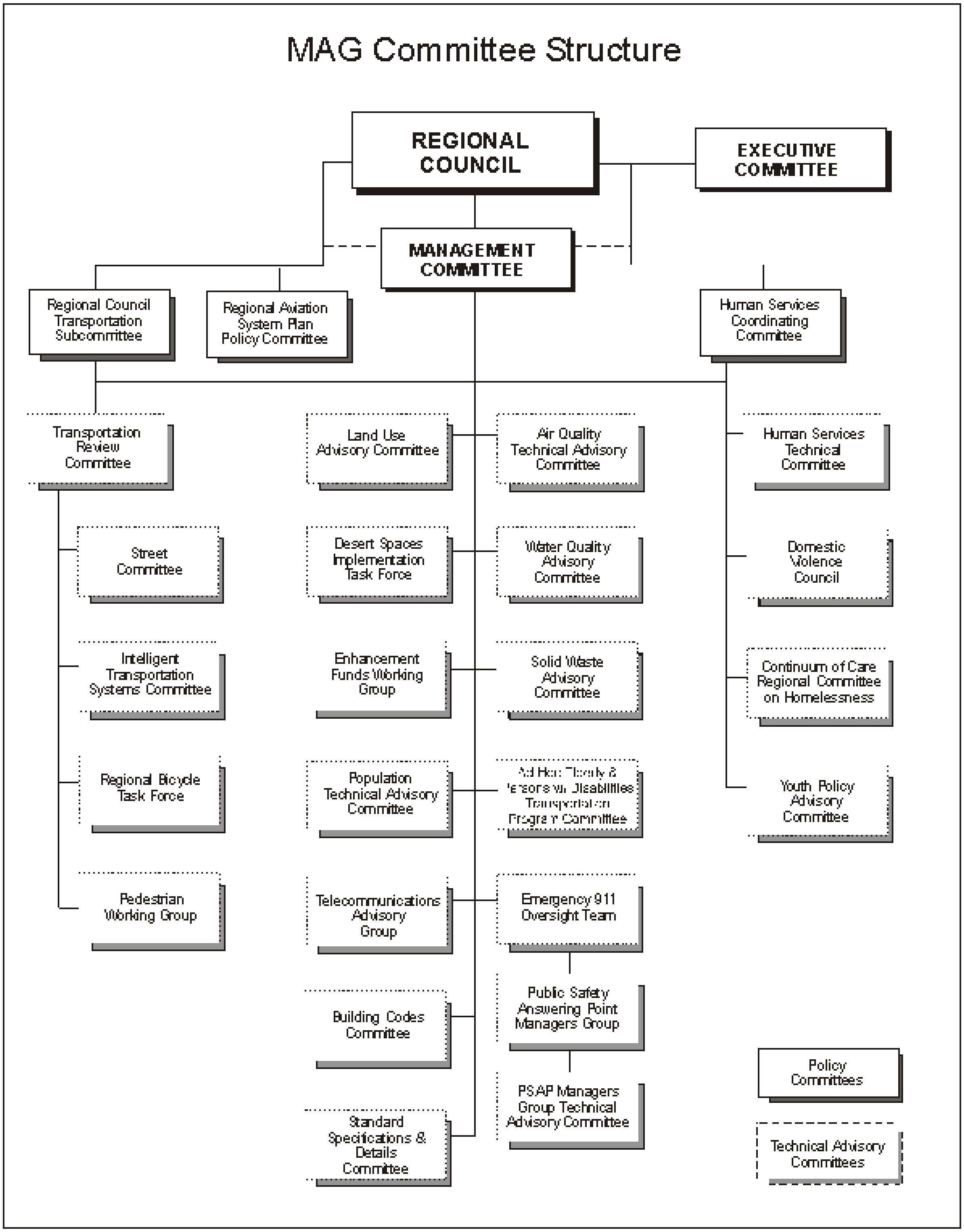

Figure 1.4. MAG committee structure.

nonattainment area plan. Formal public meetings are advertised locally at least 30 days prior to the meeting date and documentation is available for public review during this 30-day period. Draft documents are distributed to appropriate federal, state, and local agencies for review and comment during this period. Comments received are analyzed with a staff response for consideration by the MAG Regional Council before taking approval action. Documentation of the comments and responses are incorporated into the plan document.

Due to the technical complexity of many MAG programs, committees consisting of professional experts are often needed to assist in program development. The Air Quality Technical Advisory Committee is composed of representatives from eight MAG member agencies, citizens, environmental interests, health interests, automobile industry, fuel industry, utilities, public transit, trucking industry, rock products industry, construction firms, housing industry, architecture, agriculture, industry, business, parties to the Air Quality Memorandum of Agreement, and various State and Federal agencies. The role of the Technical Advisory Committee is to review and comment on technical information generated during the planning process and make recommendations to the Management Committee.

2. DOMAIN AND DATA BASE ISSUES

2.1 Aerometric Data Bases

Meteorological and air quality data to be used for the UAM modeling applications will be collected from all available valid monitoring sites in or around the nonattainment area. The Arizona Department of Environmental Quality (ADEQ) and the Maricopa County Environmental Services Department (MCESD) maintain networks collecting both air quality and meteorological data. Additional surface meteorological data will be collected from other monitoring networks include those maintained by Maricopa County Flood Control Department (MCFCD), National Weather Services (NWS), Phoenix Realtime Instrumentation for Surface Meteorological Studies (PRISMS), and AriZona METeorological network (AZMET). It should be noted that there is no upper air station in the domain under consideration. The available upper air station closest to the domain is in Tucson which is about 110 miles south of Phoenix. Special effort will be devoted in identifying any available additional sources of upper air data for the present study.

Air quality data generally serve two purposes. First, data are used to specify initial and boundary concentrations. Second, ambient measurements are used to assess the ability of the model to replicate a historical episode, that is, to evaluate model performance for the base case. These topics are addressed in the relevant sections of the modeling protocol.

2.2 Base Meteorological Episode Selection

The modeling episode day in the MAG Serious Area CO Plan [10] will be used in the CO maintenance plan. The episode day for the serious area CO plan was selected based on a review of the 1994 to 1996 monitoring data. There have been no exceedances of the CO NAAQS since 1996. Therefore, it is appropriate to continue to use the December 17, 1994 episode day for the CO maintenance plan with the prior day as the start-up day.

2.3 Modeling Domain

Selection of the modeling domain took into account the distribution of major emissions sources, the locations of the meteorological and air quality monitoring sites, and the prevailing winds associated with CO episodes. A map of the modeling domain for this application is presented in Figure 2-1. The map also indicates locations of the air quality and meteorological monitoring sites (as listed in Tables 2-1 and 2-2) and major power plants (as listed in Table 2-3) in and around the modeling domain. The shaded area represents the EPA-designated nonattainment area for CO. The origin, which is the southwest corner of the domain, is six miles south of the intersection of 115th Avenue and Dobbins Road. The grid extends 33 miles east and 24 miles north with a horizontal grid spacing of one mile. The grid contains all existing carbon monoxide air quality monitors (both NAMS/SLAMS and Special Purpose) and encompasses the central urbanized portion of the nonattainment area.

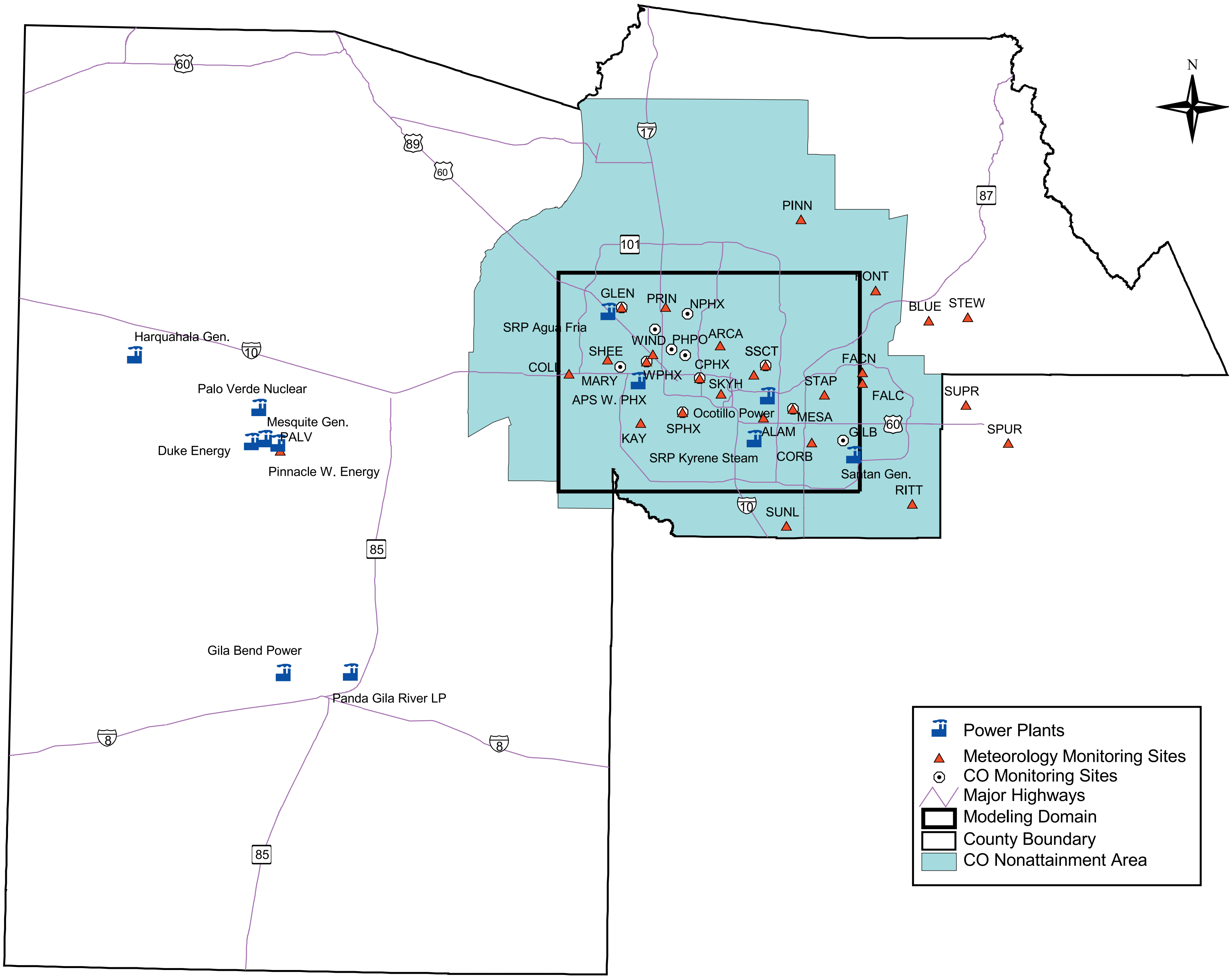

Figure 2-1. The proposed modeling domain.

Table 2-1. CO monitoring sites.

Abbr.	Name	Site Operator	Location	UTM (Zone 12, m) Easting	Northing	Wind	O_3	CO	NO	NO_2
CPHX	Central Phoenix	MCESD	1845 East Roosevelt	403224	3702365	✓	✓	✓	✓	✓
GILB	Gilbert	MCESD	Guadalupe & Linsey Rd.	428468	3691346	✓		✓		
GLEN	Glendale	MCESD	6000 West Olive	389475	3714845	✓	✓	✓		
MARY	Maryvale	MCESD	6180 West Encanto	389221	3704348		✓	✓		
MESA	Mesa	MCESD	370 South Brooks	419633	3696938	✓	✓	✓		
NPHX	North Phoenix	MCESD	601 East Butler	401095	3713719	✓	✓	✓		
OCOT	Ocotillo	SPM	32-25 West Ocotillo	395309	3710956			✓		
PHPO	Phoenix Post Office	ADEQ	3905 N. 7th Ave.	400656	3706396			✓		
SPHX	South Phoenix	MCESD	Central Ave & Broadway	400209	3696337	✓	✓	✓		
SSCT	South Scottsdale	MCESD	2857 North Miller Road	414851	3704625	✓	✓	✓	✓	✓
SUPR	Supersite	ADEQ	4530 N. 17th Ave.	398290	3707463		✓	✓	✓	✓
WPHX	West Phoenix	MCESD	3847 West Earll Road	393893	3705301	✓	✓	✓	✓	✓

Table 2-2. Meteorological monitoring stations.

Abbr.	Name	Site Operator	Location	UTM Zone 12 (m)	
				Easting	Northing
ALAM	Alameda	PRISM	Southern Ave & Dorsey Ln	414518	3695417
ARCA	Arcadia	PRISM	Bamelback Rd & 40th St.	406863	3708085
BLUE	Blue Point	MCESD	Usery Pass & Bush Highway	443644	3712520
COLL	Collier	PRISM	107th Ave & I-10	380172	3703143
CORB	Corbell	PRISM	McQueen Rd. & Guadalupe Rd	422957	3690973
CPHX	Central Phoenix	MCESD	1845 East Roosevelt	403224	3702365
FACN	Falcon	PRISM	McDowell Rd & Greenfield Rd	431961	3703348
FALC	Falcon Field	MCESD	4530 East Mckellips	431884	3701512
FLAG	Flagstaff / Pullian	NWS	6200 S. Pulliam Dr.	438853	3888399
FONT	Fountain	PRISM	Coyote Dr & El Lago Blvd.	434202	3717838
GLEN	Glendale	MCESD	6000 West Olive	389475	3714845
KAY	Kay	PRISM	43rd Ave and Lower Buckeye Rd.	392837	3694481
MESA	Mesa	MCESD	370 South Brooks	419633	3696938
PALV	Palo Verde	ADEQ	36248 W. Elliot Rd	329369	3689549
PERA	Pera	PRISM	McDowell Rd & Cross Cut Canal	412777	3702948
PINN	Pinnacle Peak	MCESD	25000 Windy Walk Way	421092	3730363
PRES	Prescott / Municipal	NWS	6546 Crystal Lane	368674	3834968
PRIN	Pringle	PRISM	23rd Ave & Dunlap Rd	397208	3714898
RITT	Rittenhouse	PRISM	Ellsworth Rd & Queen Creek Rd	440647	3680162
SHEE	Sheely	PRISM	71st Ave & Osborn Rd	386991	3705648
SKYH	Sky Harbor Intl Airport	NWS	Sky Harbor Intl Airport	407040	3699582
SPHX	South Phoenix	MCESD	Central Ave & Broadway	400209	3696337
SPUR	Spurlock	PRISM	US 60 & Kings Ranch Rd.	457642	3690913
SSCT	South Scottsdale	MCESD	2857 North Miller Road	414851	3704625
STAP	Stapley	PRISM	Stapley Dr & Consolidated Canal	425245	3699424
STEW	Stewart Mountain	PRISM	Near Stewart Mountain Dam	450493	3713121
SUNL	Sun Lakes	PRISM	Dobson Rd & Riggs Rd	418543	3676318
SUPR	Superstition	PRISM	Cactus Rd & Junction St.	450104	3697632
TUC [a]	Tucson / Int'l Airport	NWS	7005 S. Plumer Ave.	506320	3554991
WIND	West Indian School	MCESD	33rd Ave. & W. Indian Sch. Rd.	395007	3706551
WINS [b]	Winslow / Municipal	NWS	Airport Rd.	525466	3875992
WPHX	West Phoenix	MCESD	3847 West Earll Road	393893	3705301

[a] The monitoring site provided both upper-air and surface meteorological measurements.

[b] The monitoring site provided only upper-air meteorological measurements.

Table 2-3. Major power plants in the Maricopa County.

Power Plant	Location	City	UTM (Zone 12, km)	
			Easting	Northing
APS West Phoenix Power Plant	Hadley St.	Phoenix	392414	3701190
Duke Energy Arlington Valley [a] LLC.	Elliot Rd.	Arlington	324282	3690470
Harquahala Generating Co. LLC. [a]	Harquahala Valley Rd.	N/A[b]	303688	3705787
Mesquite Generating Station [a]	Elliot Rd.	Arlington	326602	3691016
Ocotillo Power Plant	University Dr.	Tempe	415224	3698573
Palo Verde Nuclear Generating [a] Station	Wintersburg Rd.	Tonopah	325615	3696527
Panda Gila River LP. [a]	Watermelon Rd.	Gila Bend	341737	3649850
Pinnacle West Energy Corp. [a]	363rd Ave.	Arlington	328940	3690200
Santan Generatin Plant	Val Vista Dr.	Gilbert	430407	3688183
SRP Agua Fria	Northern Ave.	Glendale	387108	3713387
SRP Kyrene Steam Plant	KyreneRd.	Tempe	412877	3691004
Gila Bend Power Generation [a] Station	Citrus Valley Rd.	Gila Bend	329845	329845

[a] The power plants were expected to be in operation after 1994.

[b] Harquahala Generating Co. LLC is in an unincorporated section of Maricopa Cty., near the intersection of Courthouse and Harquahala Valley Rds.

2.4 Horizontal Grid Resolution

The horizontal grid resolution to be applied to the modeling domain is one mile by one mile, or 1.609 kilometers by 1.609 kilometers. The grid spacing should allow sufficient resolution of the major emissions sources.

2.5 Number of Vertical Layers

The number of layers in the vertical direction to be used in the Urban Airshed Model simulations is proposed to be two, with one layer above the morning mixing height.
(which is called “diffusion break” in UAM). The top of the modeling domain (which is called “region top” in UAM) will be specified above the mixing height by at least the depth of one upper layer cell. This will be done by setting the region top value equal to the maximum mixing depth plus the minimum depth of the upper layer cells. Minimum vertical cell size will be 20 m below the diffusion break and 20 m above it, following the EPA Guidelines [4].

2.6 Emission Inventory

The UAM Emissions Preprocessor System (EPS2.0) [8] will be used to process the emission inventory. The emission inventory consists of emissions from various sources including stationary points, area, onroad mobile, and nonroad mobile sources. Onroad mobile source emissions for 1994 will be created using the MAG M6link program. M6link uses MOBILE6 to create the appropriate emission factors for 1994. The starting point for the emission inventory for all sources except onroad mobile will be the 1993 periodic inventory for CO developed by MCESD [23]. This inventory will be factored to the episode day in 1994. The 1999 periodic inventory for CO will be projected to 2006 and 2015 for future year modeling. The emissions will be temporally adjusted and spatially allocated in the grid cells using EPS2.0.

The maintenance year modeling inventories will reflect emissions expected to occur in December of 2015 with current committed measures in place. The general methodology for creating future-year maintenance emission inventories will be based on the EPA guidance document for preparing emissions projections [17]. This adjustment will entail the use of growth factors, ongoing control programs and retirement rates for obsolete sources of emissions. The resulting modeling inventories will be used as a starting point for determining whether the standard is maintained in the maintenance year using current committed measures.

The EPS2.0 consists of a set of FORTRAN programs (modules) that are executed sequentially in order to prepare the gridded emissions inventory for use by UAM. The programs are as follows:

PREPNT: Prepares annual or seasonal point source inventory for further processing; identifies which sources are to be treated as elevated by the UAM.

PREAM: Prepares annual or seasonal county-level area and mobile source emissions for further processing.

LBASE:	Prepares link-based mobile source emission estimates for further processing and disaggregates total emissions into individual components (used exclusively for aviation-related emissions).
CNTLEM:	Adjusts emission levels to reflect the effects of anticipated growth or implementation of proposed controls.
CHMSPL:	Assigns input hydrocarbon emissions to chemical species expected by the chemical mechanism.
TMPRL:	Temporally adjusts emissions from annual, seasonal, or typical season day to episodic levels.
GRDEM:	Spatially allocates emissions based on source location, link location, or gridded spatial surrogate indicators; converts to a UAM-ready inventory of low-level emissions.
PSTPNT	Reformat elevated point sources to be UAM-ready.
MRGUAM:	Merges several files for area, mobile, and low-level point source emissions into one UAM-ready emissions file.
RPRTEM:	Summarizes emission totals for the modeling domain by category.

The EPS2.0 is described in detail in the User's Guide [8].

2.6.1 Consistency With Periodic Emission Inventories

A comparison of the 1994 modeling inventory (grown from the 1993 Periodic Inventory) and the 1996 Periodic Inventory was made as a part of the Serious Area CO attainment demonstration [10]. The comparison revealed that the most recent assumptions regarding base year emissions and projection methodologies were incorporated into both inventories analyzed. Therefore, it was not necessary to backcast emissions from the more recent periodic inventory to the 1994 modeling episode day. The 1993 Periodic Inventory will be used for all sources except onroad mobile as the basis for the 1994 base year validation in the CO maintenance plan.

The EPA guidance document on the emission inventory requirements [15] was used in the development of the inventory. The inventory will be adjusted to be consistent with the meteorological conditions (e.g. the seasons) during the episode day. Then, the resulting episode day emissions will be adjusted to reflect control programs and activity levels prevailing during the modeling episode days. These adjustments will result in modeling inventories of the base year episode days for CO.

The CAAA of 1990 required that periodic CO emission inventories be prepared at three-year intervals for all CO nonattainment areas. The latest periodic CO inventory was prepared for 1999 by the Maricopa County Environmental Services Department in November, 2001 [12]. The 1999 periodic CO inventory will be adjusted to reflect emissions expected to occur in 2006 and 2015. The general methodology for creating future-year baseline emission inventories will be based on the EPA guidance on the preparation of emission projections [17]. This adjustment will entail the use of growth factors, ongoing control programs, and retirement rates for obsolete sources of emissions. The growth factors used for 2006 and 2015 will reflect draft interim County population forecasts prepared by the Arizona Department of Economic Security, based on the 2000 Census. The resulting modeling inventories will represent the 2006 and 2015 base case inventories. Committed measure modeling runs will be prepared by applying credit for appropriate committed control measures to the 2006 and 2015 base case inventories.

Documentation will be provided to show that emission data used in the modeling have been made available in the periodic emission inventories in accordance with applicable guidance and regulations.

2.6.2 Treatment of Mobile Sources

On January 29, 2002, EPA announced the official release of the MOBILE6 model for regulatory use outside of California. MOBILE6 is the latest update to the MOBILE model developed by EPA for the purposes of estimating motor vehicle emission factors for hydrocarbons, carbon monoxide, and oxides of nitrogen. The onroad mobile source emissions for the maintenance plan will be developed using the MOBILE6 model. It should be noted that the onroad mobile source portion of the 1993 and 1999 Periodic CO Inventories [23,12] was developed using the MOBILE5a model. Since MOBILE6 includes major revisions in emission factors for onroad mobile sources, it is expected that there will be noticeable differences between the periodic and modeling inventories for onroad mobile sources.

MOBILE6 uses a variety of inputs. Each modeled scenario will require at least ten runs: a minimum of one Inspection and Maintenance (I/M) run and a non-I/M run for each of the five area types included in the air quality modeling area; central business district, urban, urban fringe, suburban, and rural. The results from these runs will be weighted appropriately to reflect the actual proportions of I/M and non I/M vehicles within the nonattainment area. In addition, the inputs for each run will include Reid Vapor Pressure (RVP), oxygen, and sulfur gasoline content values appropriate for the summer CO season. The temperature range used will reflect episode day conditions in Maricopa County, Arizona for the episode chosen. Note that these values may be updated depending upon the final episode day choice. The 2006 and 2015 committed measure package runs will reflect control measure assumptions for the pertinent commitments contained in the MAG Moderate Area CO Plan [9] and Serious Area Plans for both CO and PM-10 [10,11], where appropriate.

MOBILE6 generates emission factors which incorporate local vehicle speeds, episodic temperature, and hot/cold operating modes. These emission factors will be utilized by the M6Link program in estimating onroad motor vehicle emissions for the MAG region. The M6Link system is briefly described below.

The M6Link system is a FORTRAN-based series of two components (M6Link1 and M6Link2) that may be applied at the regional level to examine transportation and related air quality issues. The system is designed to first read in files created by the MAG EMME/2 transportation models, and extract the relevant data needed for an air quality analysis, including data needed to run the MOBILE6 model. The M6Link1 extracts data such as roadway link speeds, locations, and vehicle miles of travel (VMT) and assigns link VMT to the correct hour and air quality grid cell accordingly. M6Link1 also factors link VMT to be consistent with Highway Performance Monitoring System VMT by functional system. This first component also outputs summary data.

The MOBILE6 program is run using the output from M6Link1 as part of its input data. The output from MOBILE6 is then used as one of the inputs to M6Link2, the second component of the M6Link system. M6Link2 combines the output from M6Link1 and the output of MOBILE6 to produce hourly gridded emissions, suitable for input to the Urban Airshed Model (UAM). These results incorporate locally-derived hourly VMT splits, vehicle speed data, VMT by four vehicle classes by area and roadway type, fuel characteristics, and temperatures to ensure results appropriate to local conditions. In addition to UAM-ready files, M6Link2 produces tables summarizing vehicle miles traveled (VMT) and vehicle hours traveled (VHT) by facility type and area type. Also, tables summarizing emission totals by hour, facility type, or emissions source (i.e. exhaust vs. evaporative) are produced. The UAM EPS2.0 will be used to combine the M6Link output with the emissions of other source categories (e.g., point, area, and nonroad mobile source emissions) to create the EMISSIONS file used by UAM.

2.6.3 Temporal Allocation of Emissions

The 1994 modeling emission inventory will be prepared according to the emission inventory forecasted from 1993 to 1994 by MCESD. Emissions in the MCESD 1999 inventory are provided either as annual averages or as typical peak CO season day values except for peaking power plants. Emissions from the peaking power plants for the modeling purposes will be based on the actual operating schedule provided by MCESD. All other point sources, along with area, nonroad mobile, and aviation sources will be resolved temporally based on profiles for seasonal activity, activity provided by day of week, and diurnal patterns of activity. The UAM EPS2.0 will be used to convert to episode day values by applying monthly and day-of-week adjustment factors. Typical peak CO season day emissions correspond to an average weekday during the winter season, defined as November 1998 through January 1999 in the 1999 periodic inventory. To convert these values to average December weekday and weekend day values in 1994, EPS2.0 applies an adjustment factor representing the ratio of December emissions to average winter emissions for each source type.

For the 2006 and 2015 future years, the major point sources will be allocated according to projected operating schedule data where available. For other point, area, and nonroad mobile sources, the EPS2.0 program CNTLEM will be used to project the 1999 periodic inventory to future years by multiplying appropriate growth factors. The growth factors will be based on socioeconomic surrogates and population projections.

The modeling inventory of the 1994 base case and the committed measure package for the 2006 and 2015 future years will reflect the impact of the committed control measures where appropriate. The 2015 inventory will be used for the modeling analysis to demonstrate the modeled maintenance status. The modeling inventories will be compared to the periodic inventories to ensure that the most appropriate assumptions for building modeling inventories are used.

2.6.4 Spatial Allocation of Emissions

Point sources will be spatially allocated according to the coordinates (e.g. UTM or latitude/longitude) of each source. Area and nonroad mobile source emissions will be spatially distributed based on surrogate factors that indicate emission level or activity. For this analysis, projections based on the data from the U. S. Census, appropriate land use data, and general plan data will be used use for the spatial allocation factors for all of the area and nonroad mobile sources.

2.7 Specification of Initial and Boundary Conditions

Available air quality data collected within or around the modeling domain will be used to derive the initial concentrations. A distance-weighted interpolation will be used to generate horizontal gridded initial concentrations for the surface layer. A constant vertical concentration profile will be specified for each grid column assuming that concentrations were well mixed below the region top of the modeling domain during the first simulation hour.

Because of the generally stagnant weather conditions, hourly boundary conditions of CO will be set to EPA recommended background values for all layers.

2.8 Wind Field Specification

Following the EPA Guideline [4], the EPA recommended Diagnostic Wind Model (DWM) [7] will be used to generate the UAM gridded wind fields. This model incorporates available observations and provides information on terrain-induced air flows in regions where observations are absent. The modeling domain for DWM will be a few cells larger at the four boundaries than the UAM domain. The wind fields for the UAM applications will be a subset of the DWM wind fields. This approach will further diminish the errors propagating from the boundaries to the area of interest.

2.9 Mixing Depths

The mixing depths contained in the UAM DIFFBREAK file will be calculated using the MIXEMUP procedure [13]. The procedure, which is based on a one-dimensional model developed by Benkley and Schulman (1979) [21], consists of subjective and objective (computer-based) analysis of the data. Using this technique, hourly mixing heights are calculated for a given surface location using a nearby, representative upper-air sounding and the local hourly surface data. During the nighttime hours, when mixing is primarily mechanical, the mixing-height is a function of wind speed. A daytime convective mixing scheme is employed after sunrise. The height of the daytime mixed layer is estimated to be that point at which a dry-adiabatic air parcel anchored at the surface temperature intersects the 1200 GMT (0500 MST) sounding. The time of sunrise and sunset are specified as the hour at which the solar zenith angle, supplied by the SUNFUNC program (included with the UAM package) [6] becomes less than and greater than 90 degrees, respectively. Hourly mixing heights will be calculated for a given surface location using a nearby, representative upper-air temperature sounding and the local hourly surface wind and temperature data.

2.10 Sources of Other Input Data

For simulating CO concentrations, the species CO is denoted as being unreactive. Therefore, CO is the only species designated in the UAM CHEMPARAM file.

Surface temperature data are used to adjust chemical reaction rates in UAM. Because UAM will be exercised in an inert mode for this study, no surface temperature data will be used.

Because no deposition will be allowed in the UAM CO simulations, the UAM TERRAIN file containing values of the surface roughness and deposition factor for each grid cell can be omitted. A default surface roughness factor of 0.5 and a constant deposition factor of 1.0 will be included in the SIMCONTROL input file. However, the values specified will have no effect on simulated concentrations.

Other input variables including cloud cover, exposure class, and UV radiation will not be required due to the inert mode of the simulations.

3. QUALITY ASSURANCE AND DIAGNOSTIC ANALYSES

This chapter discusses the procedures to be followed for quality assurance of component data input fields and diagnostic testing of the base case episode. The purpose is to uncover potential data input gaps that, when corrected, lead to improved model results. The quality assurance helps users of the modeling results to have some measure of confidence in the ability of the model to capture key meteorological features in order to predict future CO concentration levels.

3.1 Quality Assurance Tests of Input Components

The purpose of this testing is to establish that apparently good model results are the result of valid model inputs and assumptions, and not the result of compensating errors in input data. Prior to conducting a base case simulation, individual air quality, meteorological, and emissions fields will be reviewed for consistency and obvious omission errors. Both spatial and temporal characteristics of the data will be evaluated. Examples of component testing include:

- Air Quality: Check for correct order of magnitude; compare values with monitored data.
- Emissions: The emissions inventory will be tabulated, plotted, and examined. The quality assurance procedures will include documentation of major assumptions, careful accounting of emissions totals throughout the development process, verification of spatial distribution of emissions against known source locations and emission strengths, and identification of missing or unreasonable data values.
- Meteorology: If data are available, plot surface and elevated wind vectors to compare the simulated winds with monitoring data and weather maps for consistent patterns; compare mixing height fields with sounding data.

It is very important to perform the quality assurance tests prior to performing model simulation, because errors uncovered by the quality assurance testing of component input fields might be extremely difficult to diagnose later on in the modeling process where errors could arise from any subset of the data inputs.

3.2 Diagnostic Tests of Base Case Simulation

After conducting the above quality assurance tests, UAM will be conducted for the base case episode. Emphasis will be placed on correctly depicting the areawide distribution and timing of observed CO concentrations. Spatial and time series plots will be used to assess model behavior.

To aid the interpretation of simulation results, predicted and observed CO concentration maps will be constructed for each base case episode. Concentration maps present spatial distribution of CO concentrations. Maps at one or two hour intervals will be constructed over periods of most interest. While a typical period might be defined as early morning to late afternoon for the day of highest CO concentration, it is useful to look at most time intervals under recirculation, stagnation, and transport conditions. Consideration will also be given to constructing a map which depicts the highest predicted daily maximum CO value for each grid cell. Examples of various mapping techniques are described in Tesche et. al. [22]. The predicted concentration to be used in the time-series plots will be defined using the same method for deriving predicted concentrations for the model performance evaluation. This method consists of a four-cell weighted average using bilinear interpolation of the predictions from the nearest four grid cells to the monitor location and is also based on Tesche et. al. [22].

Additional diagnostic tests for the base case will also be considered depending on the availability of time and resources. The basic diagnostic tests can be considered part of a standard operational model evaluation and therefore complement and extend the various numerical and graphical measures of model performance by providing a straightforward measure of model robustness. A number of sensitivity simulations will be conducted to determine the response in CO concentrations to changes in key inputs. The simulations will include some of the following as recommended in the guidance document [4] for areawide CO modeling:

- **Zero Boundary Conditions**. Inflow concentrations at the lateral boundaries and top of the modeling domain will be reduced to zero. Sensitivity of the concentrations in the inner core and downwind portions of the modeling domain provide a measure of the influence of the boundary conditions. This simulation will provide assurance that the upwind extent of the domain is adequate.

- **Zero Initial Conditions**. Initial concentrations for all grid cells will be reduced to zero. Sensitivity of concentrations within the modeling domain provide a measure of the influence of the initial conditions. Changes of less than a few percent indicate that the initial conditions are not dominating concentration estimates within the domain.

- **Diffusion Break Heights**. Diffusion break heights will be doubled for one simulation and halved for another. Sensitivity of the concentrations within the modeling domain provide a measure of the influence of diffusion break heights. These simulations will provide assurance that the diffusion break heights are adequate.

More elaborate diagnostic analysis tests involve sensitivity-uncertainty studies that examine model responses to a range of variation in input parameters (e.g., various changes in emission levels, in emission speciation, etc.). All diagnostic steps will be documented to avoid misinterpretation of model performance results. Once confidence is gained that the simulation is based on reasonable interpretations of observed data, and model concentration fields generally track, spatially and temporally, known urban plumes, a performance evaluation based on numerical measures will be conducted for each base case episode.

3.3 Test Results/Input Modifications

Following the diagnostic modeling analyses, the simulation results will be carefully examined for possible modification or refinement of the input components. On a case-by-case basis, the performance of UAM for each base case simulation will be evaluated to determine whether or not it is acceptable, with or without input modifications. The model performance criteria listed in the EPA guidance [4], also presented in the next chapter (Chapter 4), will be used in the evaluation.

4. MODEL PERFORMANCE EVALUATION

4.1 Performance Evaluation Tests

Simulated and observed eight-hour average CO concentrations at each monitoring station will be utilized in statistical performance goals. Some general model performance guidelines have been outlined in the EPA guidance [4]. Among the general guidelines are the following statistical performance goals:

- **Unpaired (time or space) peak 8-hour prediction accuracy within ±35%** - This measure quantifies the difference between the highest observed 8-hour value and the highest simulated 8-hour value over all hours and monitoring locations.

- **Paired (time and space) mean absolute error in 8-hour peak prediction accuracy values greater than 5.0 ppm less than 30%** - This measure quantifies the difference between the highest observed 8-hour value and the highest simulated 8-hour value at the time and location of each observed maximum.

- **Paired (space only) mean absolute error in the predicted time of the 8-hour peak concentration value greater than 5.0 ppm less than 2 hours** - This measure quantifies the difference between the highest observed 8-hour value and the highest simulated 8-hour value at the location of each observed maximum within a window time.

In general, performance measures that fall within or below these ranges would be considered acceptable. However, as a result of the limited monitoring network, statistical results alone may give a false reflection of model performance. Thus, graphical procedures will be used in conjunction with statistical measures to assess model performance.

Time-series plots will be developed for each monitoring station in the modeling domain to depict the hourly 8-hour average simulated and observed concentrations for the simulation period. The time-series plots reveal the model performance in reproducing the peak observed value, the presence of any significant bias within the diurnal cycle, and a comparison of the timing of the simulated and observed maxima.

Ground-level isopleths will be developed for the CO maxima. The corresponding observed concentrations will be superimposed on the simulated concentration isopleths to analyze spatial patterns and CO magnitudes.

If the statistical results do not meet the recommended performance criteria, and graphical analyses also indicate poor model performance, an alternative episode will be chosen or the EPA regional office will be contacted for review and approval of the base case episode before any future-year simulations are undertaken.

5. MAINTENANCE DEMONSTRATION

5.1 Identification of Future Years

The primary purpose of conducting areawide modeling is to demonstrate control strategy effectiveness in maintaining the 8-hour CO NAAQS for at least ten years after the Maricopa County Nonattainment area has been redesignated to attainment status. In determining the amount of lead time to allow, EPA indicated that 18 months, as granted in section 107(d)(3)(D) of CAAA, should be assumed for EPA to approve a redesignation request [2]. Due to uncertainties regarding the time that the area will be redesignated to attainment, 2015 will be modeled to assure that the 8-hour CO NAAQS is maintained at least ten years past an official notice of redesignation to attainment by EPA.

In addition to 2015, a second year of 2006 will be modeled and included in the maintenance plan in order to provide a 2006 mobile source emissions budget for conformity purposes.

5.2 Identification of Control Measures

The committed control measures already implemented for CO will be evaluated. If additional control measures are needed, they will be submitted to the MAG Air Quality Technical Advisory Committee for consideration for the Suggested List of Measures. Following Regional Council approval of the Suggested List of Measures, the local jurisdictions and the Legislature will be requested to consider the implementation of the measures under their respective authorities. Each jurisdiction determines which measures are feasible for implementation by that jurisdiction. These measures then become the committed measures. The committed control measure package will be incorporated into the emission inventory for UAM. Based upon the results of the UAM simulations, it will be determined if the control strategies demonstrate maintenance of the CO standard.

If additional control measures are needed, the procedures for selecting the control strategy scenarios will conform to the State Implementation Plans (SIPs) [9,10,11], follow current EPA guidance [4] or any deviation from the guidance will be fully justified, and incorporate our present understanding of the urban/regional CO problem. The 2006 and 2015 future base case runs will reflect control measure assumptions for the commitments contained in the SIPs [9,10,11], where appropriate.

5.3 Determination of Maintenance Demonstration

To demonstrate maintenance of the 8-hour CO NAAQS, the results from the urban airshed modeling analyses should not show predicted 8-hour maximum CO concentrations greater than 9.0 ppm anywhere in the modeling domain for the episode modeled. The maintenance demonstration will follow the deterministic procedure prescribed in the EPA Guideline [4].

5.3.1 Modeling Reliability and Uncertainties

UAM is considered the appropriate regulatory tool available for projecting the future air quality effect of projected emission changes. However, future year modeling results should not be considered absolute guarantees of future air quality. Uncertainties in the models used and their inputs, along with meteorological variability, may result in actual future air quality that differs from predicted air quality. Higher concentrations than those modeled may occur for any of the following reasons:

- Meteorological variability - In selecting a modeling episode, the goal is to select periods that represent worst-case conditions. If episodes with more severe stagnation occur in the future, emission controls designed to reach attainment for a historical episode may not be adequate.

- Emissions variability - Emission estimates are based on average source usage, taking into account seasonal, diurnal, and day-of-week factors. Onroad mobile emissions take into account day-specific temperatures as well. However, emissions on a given day may be greater than average due to greater than average usage, lower temperatures, or other factors.

- Uncertainty in growth projections - If growth projections underestimate true growth rates, future year emissions may be greater than projected emissions.

- Uncertainty in control measure effectiveness - If actual emission reductions from a given control measure are smaller than the estimated emission reductions, future concentration will be greater than modeled concentrations.

- Model performance - If the model under predicted concentrations at a particular site, or has failed to capture a particular aspect of the meteorology, then a level of emission reduction that appeared to be adequate during modeling may not actually be adequate.

By similar reasoning, future measured concentrations may be lower than modeled concentrations because of these variabilities and uncertainties. In addition, future measured concentrations will still be limited to monitoring sites. Since a maintenance demonstration based on grid modeling requires concentrations at all grid cell within the domain to be below the standard, it is likely that simulated concentrations at all monitoring locations will be well below the standard.

As a result, although for regulatory purposes a modeled peak 8-hour average CO concentration below 9.0 ppm is adequate to demonstrate maintenance, modeling results are better thought of as a point on a probability distribution. If the modeled peak value is far below 9.0 ppm, the probability that maintenance will result, even under differing conditions, is high. If the modeled peak is very close to 9.0 ppm, however, the probability that maintenance will result may be well below 100 percent given the probabilistic nature of the modeling process.

6. SUBMITTAL PROCEDURES

The following items will be delivered to the EPA regional office during the modeling study:

- Modeling protocol (this document)

- Technical Support Document which addresses the entire modeling analysis, including UAM input preparation and application, and maintenance demonstration.

MAG will provide this protocol document to the Air Quality Planning Team and the EPA Region IX Office for review and comments.

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18. U.S. Environmental Protection Agency (August 2001) “Draft User’s Guide to MOBILE6.0 - Mobile Source Emission Factor Model”. EPA420-D-01-003. Assessment and Standards Division, Office of Transportation and Air Quality.

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ATTACHMENT I

Interagency Memorandum of Agreement

MEMORANDUM OF AGREEMENT

AMONG

THE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

AND

THE ARIZONA DEPARTMENT OF TRANSPORTATION

AND

MARICOPA COUNTY, BY AND THROUGH THE MARICOPA COUNTY ENVIRONMENTAL QUALITY AND COMMUNITY SERVICES AGENCY

AND

THE MARICOPA ASSOCIATION OF GOVERNMENTS

PURPOSE

The purpose of this Memorandum of Agreement is to provide the framework and guidelines to promote coordinated decision making in planning, development, and implementation, and enforcement of those actions necessary to attain and maintain the National Ambient Air Quality Standards in Maricopa County, hereafter referred to as the Nonattainment Area Plan, or NAP. This Memorandum is required pursuant to A.R.S. 49-406 D. and E. The Memorandum also provides the framework and guidelines for preparing plans designed to address other air pollution problems of regional concern.

SCOPE

This Memorandum is designed to address the control of the following pollutants: Carbon Monoxide, Ozone, Particulates, and Other Air Pollution Problems of Regional Concern.

The geographical area of concern is Maricopa County or the area specifically designated by the Administrator of the U.S. Environmental Protection Agency as not having attained the National Ambient Air Quality Standards for one or more of the pollutants named above.

RESPONSIBILITIES AND AUTHORITIES

The Arizona Department of Environmental Quality (ADEQ) has the primary authority in the State of Arizona for air pollution control and abatement. ADEQ is charged with preparation, development and maintenance of the State Implementation Plan (A.R.S. § 49-404); designation of areas of the state with respect to compliance with the National Ambient Air Quality Standards (A.R.S. § 49-405); and assuring that nonattainment area plans are implemented (A.R.S. § 49-406 J.). ADEQ has original jurisdiction and control over portable, mobile, and specific types of stationary air pollution sources (see A.R.S. § 49-402 A.). In addition, ADEQ is responsible for development of stationary source permitting procedures and standards (see A.R.S. § 49-480 B.). ADEQ is also responsible for providing technical assistance to political subdivisions of the State for implementing air pollution control programs (A.R.S. § 49-424 A.8.), conducting research on the amounts of hazardous air pollutants in ambient air and their impacts on human health (A.R.S. § 49-426.06); management and implementation of programs under the Air Quality Fee Fund (A.R.S. § 49-551), implementation of the Vehicle Emissions Inspections Program (A.R.S. § 49-521 through 550), and conducting research on vehicular emissions and clean burning fuels (A.R.S. § 49-553). The Department may delegate authority to a county for implementing air pollution control statutes (A.R.S. § 49-424 B.)

The Arizona Department of Transportation (ADOT) has exclusive control over state highways and all other state owned transportation systems (A.R.S. § 28-104). This includes the responsibility of multi-modal state transportation planning, cooperation with local governments, coordination of transportation planning with local governments, investigation of new transportation systems, and advising local governments concerning the development and operation of public transit systems (A.R.S. § 28-104).

The ADOT Director shall also enter into agreements on behalf of the state with political subdivisions for the improvement, maintenance and construction of mass transit systems, and shall provide rules for the application for and expenditure of all mass transit funds (A.R.S. § 28-108).

In addition, ADOT is authorized to conduct demonstration projects to evaluate the effectiveness of new, extended, improved or integrated public transportation services and carpooling or vanpooling activities in meeting regional transportation needs or in improving air quality (A.R.S. § 28-2611). These projects are funded by an annual distribution of $400,000 from the air quality fund (A.R.S. § 49-551). ADOT must also support ADEQ on reporting to the Legislature results of mobile source emissions Research, where applicable, per A.R.S. § 49-553.

The Maricopa County Environmental Quality and Community Services Agency (MC EQ&CSA) is the local air pollution control department for Maricopa County. The Agency has jurisdiction over air pollution sources not explicitly reserved for state jurisdiction (A.R.S. § 49-402); the Agency is delegated authority from the State of Arizona to regulate certain portable air pollution sources initially reserved for state jurisdiction (A.R.S. § 49-424); the Agency operates the Regional Travel Reduction Program (A.R.S. § 49-582 et seq), and is the principal government sponsor for the Voluntary No Drive Days Program (A.R.S. § 49-506). The Agency is also responsible for monitoring the ambient air quality of the region (A.R.S. § 49-473) through collecting and analyzing air quality data.

Within the Maricopa County Environmental Quality and Community Services Agency, the Assistant County Manager of the Agency is designated as the Air Pollution Control Officer. The Air Pollution Control Officer has the responsibility and authority to enforce the provisions of Article 3, Chapter 3, Title 49, "County Air Pollution Control", Arizona Revised Statutes. The Control Officer also has the responsibility for assuring adequate nonattainment plan implementation as prescribed by A.R.S. § 49-406.

The Maricopa Association of Governments (MAG) is a nonprofit Arizona corporation composed of elected officials from twenty-four cities and towns, Maricopa County, Gila River Indian Community, and the Arizona Department of Transportation. MAG has been designated by the Governor of Arizona as the lead planning organization for Maricopa County that, together with the State, is responsible for determining which elements of the State Implementation Plan revision will be planned, implemented, and enforced by State and local governments in Arizona (Governor Wesley Bolin, February 7, 1978; Clean Air Act § 174(a); and A.R.S. 49-406)). MAG is responsible for providing assistance to the Maricopa County Travel Reduction Regional Task Force and for recommending third and following year travel reduction targets, policies, standards and criteria for the Maricopa County Travel Reduction Program (A.R.S. § 49-582 and 49-588). Related directly to air quality, MAG is the official designated metropolitan transportation planning organization, and the designated agency for preparing population estimates and projections for the Maricopa County area. MAG is also responsible for making transportation/air quality conformity determinations, subject to the consultation procedures as provided by law (Clean Air Act § 176).

UNDERSTANDING/AGREEMENTS

In recognition and to facilitate the accomplishment of the foregoing, IT IS HEREBY AGREED that:

1. The Arizona Department of Environmental Quality; Arizona Department of Transportation; Maricopa County Environmental Quality and Community Services Agency; and Maricopa Association of Governments will work through a coordinated effort to prepare the MAG regional air quality plans as described in Attachments One, Three, Four, and Five. Attachment One contains a description of the generalized roles and areas of expertise of the agencies, the MAG Air Quality Planning Team, and the MAG Air Quality Policy Team. Attachment Three contains the general implementation authorities for measures in the air quality plans. Attachment Four includes provisions for tracking plan implementation; determining reasonable further progress; assurances for adequate plan implementation, and adoption of control measures. Attachment Five contains the Work Programs for Preparing Air Quality Plans.

2. The Maricopa Association of Governments will maintain the MAG Regional Air Quality Planning Process for decision making as described in Attachment Two. This Attachment contains the roles of the MAG Regional Council, MAG Management Committee, MAG Air Quality Policy Committee, and ad hoc Working Groups. MAG will coordinate the preparation of the NAPs. Representatives from ADEQ, ADOT and MC EQ&CSA will be included as ex-officio members of the MAG Air Quality Policy Committee, and active members of all working groups associated with this MAG committee.

3. The Arizona Department of Environmental Quality; Arizona Department of Transportation; Maricopa County Environmental Quality and Community Services Agency; Maricopa Association of Governments will pursue commitments to implement the measures in the NAPs. The aforementioned agencies will continue to evaluate and pursue the implementation of additional air pollution control measures as a result of the evaluations performed as described in Attachment Four.

EFFECTIVE DATE

The Agreement and all Amendments shall become effective on the date it has been signed by all parties to it.

TERM

This Agreement shall remain in effect from the effective date of the Agreement until such time it is terminated or superseded by a subsequent agreement. This Agreement may be terminated by any party to it, providing written notice of intent to terminate is provided to all other parties to the Agreement thirty days prior to the effective date of withdrawal of that party from the Agreement.

AMENDMENT

This Agreement may be amended at any time upon mutual written agreement of all parties. No agent, employee or other representative of any party to this Agreement is empowered to alter any of the terms of the Agreement, unless it is done in writing and signed by the Designated Officers of the respective parties, their authorized representatives, or duly appointed successors.

ATTEST

All terms of this Memorandum of Agreement are hereby acknowledged and agreed, as certified by the signatures of the Designated Officers affixed hereto:

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

By ______________________

Edward Z. Fox, Director, Arizona Department of Environmental Quality

Date NOV 9, 1992

ARIZONA DEPARTMENT OF TRANSPORTATION

By ______________________

James Creedon, Acting Director, Arizona Department of Transportation

Date Nov 9, 1992

MARICOPA COUNTY, BY AND THROUGH THE MARICOPA COUNTY ENVIRONMENTAL QUALITY AND COMMUNITY SERVICES AGENCY

By ______________________

Betsy Bayless, Chairman, Maricopa County Board of Supervisors

Date 11.2.92

MARICOPA ASSOCIATION OF GOVERNMENTS

By ______________________

John J. DeBolske, Secretary, Maricopa Association of Governments

Date 11.2.92

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MODELING DATA FILE LIST

The air quality modeling conducted in support of the MAG Carbon Monoxide Maintenance Plan was performed by the Maricopa Association of Governments (MAG). The MAG modeling runs were mostly performed on Hewlett-Packard 700 series workstations using the HP10.20 operating system. The exception is MOBILE6 and the first portion of M6Link, which was run on a PC using the Microsoft Windows NT operating system or a PC running the RedHat Linux operating system. The input, output, and job files utilized in the modeling effort were subsequently compiled and stored on a single data tape. The files were transferred from the MAG computers to 8mm magnetic tape using the UNIX tar (Tape file ARchiver) command. Input, output, and job files from the modeling runs are available in this principal format. To receive copies of any data files on 8mm tape, please contact Ruey-in Chiou, Air Quality Modeling Program Manager, at (602) 254-6300.

The description of where specific data files are located is noted in each section below. Some directories are further split into subdirectories pertaining whether the file is appropriate for the 1994 model year, 2015 model year, control measure package (CMP), an individual measure analysis, or the no measures package analysis. A detailed list that notes the full contents of each modeling subdirectory follows the job summary.

MOBILE6

Data tape subdirectory: ./MOBILE6

MOBILE6 was used to generate emission rate factors for onroad mobile vehicles as a function of temperature, vehicle speed, vehicle age, vehicle type, etc. These emission rate factors were derived incorporating local vehicle registration distribution data, fuel data, and other local factors. The fleet average emission rates were subsequently input to the M6Link program or the CAL3QHC model for further processing.

Files which were used to estimate emission rates for use in M6Link are in the data tape subdirectory ./mobile6 /forM6Link. Files which were used to estimate emission rates for use in CAL3QHC are in the data tape subdirectory ./mobile6 /forCAL3QHC. MOBILE6 files used to estimate the benefit from the intelligent transportation systems and traffic signal synchronization measures are in the data tape subdirectory ./mobile6 /forPostProc.

M6Link

Data tape subdirectory: ./M6Link

The M6Link program was used to prepare input UAM emission files for onroad mobile sources. The M6Link program is made up of two modules. The M6Link1 module extracts data such as roadway link speeds, locations, and vehicle miles of travel (VMT) and assigns link VMT to the correct hour and air quality grid cell accordingly. M6Link1 also factors link VMT to be consistent with Highway Performance Monitoring System VMT by functional system. The M6Link2 module combines the output from M6Link1 and the output of MOBILE6 to produce hourly gridded emissions, suitable for input to the Urban Airshed Model (UAM). These results incorporate locally-derived hourly VMT splits, vehicle speed data, VMT by four vehicle classes by area and roadway type, fuel characteristics, and temperatures to ensure results appropriate to local conditions.

The M6Link directory is divided into “ctl”, “inp”, “out”, and “medexplora” subdirectories for control and job files, input files, output files, and post processing. Each of these subdirectories is further divided into 1994, 2006, and 2015 subdirectories. The /ctr/2015 and out/2015 directories are divided into “CMP”, “IndividualMeasure”, and “NoMeasures” subdirectories. An additional directory “M6Link1stPortion” in the “out/2015" directory is for files pertaining to M6Link1 module.

Job Control Files: 1994COBase.job, 2006COCMPCasejob, 2006COCMPCase.job.NewSpeeds, 2015CMPCase.job.NoCatProgram, 2015COCutpts.job, 2015CORFG.job, 2015COTougherEnforcement.job, 2015COWaivers.job, 2015COBase.job

MEDEXPLORA Module
Data tape subdirectory: ./M6Link /medexplora

The MEDEXPLORA module converts the output from M6Link into a UAM-ready emissions input file.

Job Control Files: meduam.CO121694.M6Link, meduam.CO121794.M6Link, meduam.CO121606.M6Link, meduam.CO121706.M6Link, meduam.CO1215M6Link.rev8, meduam.CO1215M6Link.rev8.base

CAL3QHC

Data tape subdirectory: ./cal3qhc

CAL3QHC was used to estimate microscale concentrations of CO from congested intersections. The one hour CO concentrations estimated with the CAL3QHC program were averaged together to create eight hour concentrations for combination with eight hour averages created using the Urban Airshed Model. The number of CO receptors modeled at each intersection exceeded the number of monitors which the CAL3QHC program is capable of modeling in a single run. As a result, multiple CAL3QHC runs were performed for each intersection.

Job Control Files: 1994.job, 2000.job, 2010.job, cal3qhc.job1.Mar13_03.isr, cal3qhc.job1.Mar13_03.tms, cal3qhc.job2.Mar13_03.isr, cal3qhc.job2.Mar13_03.tms, cal3qhc.job3.Mar13_03.isr

Emissions Preprocessor System (EPS 2.0)

Data tape subdirectory: ./eps2

The UAM Emission Preprocessor System was used to prepare UAM-ready emission estimate files for point, area, and nonroad mobile sources. Onroad mobile emission files were prepared using the M6Link system and are described in a previous section.

The data tape directory for all EPS 2.0 files is ./eps2. The ./eps2 directory is further subdivided into “inp”, “job”, “msg”, and “out” for input files, job files, message files, and output files respectively from the EPS runs. These directories are further subdivided into five subdirectories, “1994", “2006", “2015", “2015_ind_measures”, and “2015_no_measures” for 1994 base case, 2006, 2015 with control measures, 2015 individual measures, and 2015 no measures.

PREPNT Module

The PREPNT module was used to prepare the annual or seasonal point source inventory for further processing and identifies which sources are to be treated as elevated by UAM.

Job Control Files: prp.pnt.co.94.350.98chg.tj20.job, prp.pnt.co.94.351.98chg.tj20.job, prp.co_20.06.350.6%.job, prp.co_20.06.351.6%.job, prp.co_20.15.350.15%.job, prp.co_20.15.351.15%.job

PREAM Module

The PREAM module prepared county-level area and nonroad mobile source emission estimates from the periodic inventory for further processing.

Job Control Files: pra.co.94.350.bas.job.nnrd3, pra.co.94.351.bas.job.nnrd3, pra.co.15.350.job.final, pra.co.15.351.job.final

LBASE Module

The LBASE module prepared aviation-related source emission estimates from the MAG Airport Emissions Model for further processing.

Job Control files: lbs.co.94.350.bas.job.98chg, lbs.co.94.351.bas.job.98chg, lbs.co.99.350.bas.job, lbs.co.99.351.bas.job

CNTLEM Module

The CNTLEM module was used to project the 1999 inventory to the maintenance year, and to account for measures enacted since the base year inventory. Since the CNTLEM module cannot apply stack-specific growth factors to point sources, factors for each year were applied before the PREPNT module.

Job Files: ctl.area.co.94.350.bas.job.nnrd3, ctl.area.co.94.351.bas.job.nnrd3, ctl.avi.co.94.350.bas.job.98chg.avicor, ctl.avi.co.94.351.bas.job.98chg.avicor, ctl.mvoff.co.94.350.bas.adj.job.nnrd3, ctl.mvoff.co.94.350.bas.job.nnrd3, ctl.mvoff.co.94.350.bas.ratio.job.nnrd3, ctl.mvoff.co.94.350.bas.reduce.job.nnrd3, ctl.mvoff.co.94.351.bas.adj.job.nnrd3, ctl.mvoff.co.94.351.bas.job.nnrd3, ctl.mvoff.co.94.351.bas.ratio.job.nnrd3, ctl.mvoff.co.94.351.bas.reduce.job.nnrd3, ctl.area.co.06.350.6%.job, ctl.area.co.06.350.fireplace.6%.job, ctl.area.co.06.351.6%.job, ctl.area.co.06.351.fireplace.6%.job, ctl.avi.co.06.350.bas.job, ctl.avi.co.06.351.bas.job, ctl.mvoff.co.06.350.6%.job, ctl.mvoff.co.06.350.FEDNR6.cmp.job, ctl.mvoff.co.06.350.OXY.6%bas.job, ctl.mvoff.co.06.350.OXY.FEDNRi.6%.job, ctl.mvoff.co.06.350.OXY.cmp.6%.job, ctl.mvoff.co.06.350.OXYi.6%.cmp.job, ctl.mvoff.co.06.350.bas.job, ctl.mvoff.co.06.351.6%.job, ctl.mvoff.co.06.351.FEDNR6.cmp.job, ctl.mvoff.co.06.351.OXY.6%bas.job, ctl.mvoff.co.06.351.OXY.FEDNRi.6%.job, ctl.mvoff,co.06,351.OXY.cmp.6%.job, ctl.mvoff.co.06.351.OXYi.6%.cmp.job, ctl.mvoff.co.06.351.bas.job, ctl.area.co.15.350.15%.job, ctl.area.co.15.350.bas2.job, ctl.area.co.15.350.fireplace.15%.job, ctl.area.co.15.351.15%.job, ctl.area.co.15.351.bas2.job, ctl.area.co.15.351.fireplace.15%.job, ctl.avi.co.15.350.basR2.job, ctl.avi.co.15.351.basR2.job, ctl.mvoff.co.15.350.FEDNR15.final.job, ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.350.OXYFUELS.ind.job, ctl.mvoff.co.15.350.bas2.job, ctl.mvoff.co.15.350.final+15%.job, ctl.mvoff.co.15.351.FEDNR15.final.job, ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.351.OXYFUELS.ind.job, ctl.mvoff.co.15.351.bas2.job, ctl.mvoff.co.15.351.final+15%.job, ctl.area.co.15.350.15%.job, ctl.area.co.15.350.bas2.job, ctl.area.co.15.351.15%.job, ctl.area.co.15.351.bas2.job, ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.350.bas2.job, ctl.mvoff.co.15.350.final+15%.job, ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.351.bas2.job, ctl.mvoff.co.15.351.final+15%.job, ctl.area.co.15.350.15%.job, ctl.area.co.15.350.bas2.job, ctl.area.co.15.350.fireplace.15%.job, ctl.area.co.15.351.15%.job, ctl.area.co.15.351.bas2.job, ctl.area.co.15.351.fireplace.15%.job, ctl.mvoff.co.15.350.FEDNR.ind.job, ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.350.OXYFUELS.ind.job, ctl.mvoff.co.15.350.bas2.job, ctl.mvoff.co.15.350.final+15%.job, ctl.mvoff.co.15.351.FEDNR.ind.job, ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job, ctl.mvoff.co.15.351.OXYFUELS.ind.job, ctl.mvoff.co.15.351.bas2.job, ctl.mvoff.co.15.351.final+15%.job

CHMSPL Module

The CHMSPL module was used for placeholding purposes only because CO was the only pollutant analyzed.

Job Files: chm.area.co.94.350.bas.job.nnrd3, chm.area.co.94.351.bas.job.nnrd3, chm.avi.co.94.350.bas.job.98chg.avicor, chm.avi.co.94.351.bas.job.98chg.avicor, chm.mvoff.co.94.350.bas.job.nnrd3, chm.mvoff.co.94.351.bas.job.nnrd3, chm.pnt.co.94.350.98chg.tj20.job, chm.pnt.co.94.351.98chg.tj20.job, chm.area.co.06.350.6%.base.job, chm.area.co.06.350,fireplace.6%.job, chm.area.co.06.351.6%.base.job, chm.area.co.06.351.fireplace.6%.job, chm.avi.co.06.350.base.job, chm.avi.co.06.351.base.job, chm.mvoff.co.06.350.6%bas.job, chm.mvoff.co.06.350.FEDNRi.6%.job, chm.mvoff.co.06.350.OXYi.6%.job, chm.mvoff.co.06.350.cmp6.job, chm.mvoff.co.06.351.FEDNRi.6%.job, chm.mvoff.co.06.351.OXYi.6%.job, chm.mvoff.co.06.351.cmp6.job, chm.pnt.co_20.06.350.6%.job, chm.pnt.co_20.06.351.6%.job, chm.area.co.15.350.fireplace.15%.job, chm.area.co.15.351.fireplace.15%.job, chm.avi.co.15.350.base.R2.job, chm.avi.co.15.351.base.R2.job, chm.mvoff.co.15.350.cmp.final.job, chm.mvoff.co.15.351.cmp.final.job, chm.pnt.co_20.15.350.15%.job, chm.pnt.co_20.15.351.15%.job, chm.area.co.15.350.15%.base.job, chm.area.co.15.351.15%.base.job, chm.mvoff.co.15.350.WOcm.final.job, chm.mvoff.co.15.351.WOcm.final.job, chm.area.co.15.350.fireplace.15%.job, chm.area.co.15.351.fireplace.15%.job, chm.mvoff.co.15.350.FEDNR.ind.job, chm.mvoff.co.15.350.OXY.ind.job, chm.mvoff.co.15.351.FEDNR.ind.job, chm.mvoff.co.15.351.OXY.ind.job

PSTPNT Module

The PSTPNT module was used to process the elevated CO point sources.

Job Files: pst.pnt.co.94.350.tj20.job, pst.pnt.co.94.351.tj20.job, pst.pnt.co_20.06.350.6%.job, pst.pnt.co_20.06.351.6%.job, pst.pnt.co_20.15.350.15%R2.job, pst.pnt.co_20.15.351.15%R2.job

TMPRL Module

The TMPRL module was used to temporarily allocate emissions from annual, or seasonal average day to reflect the modeled episode. Point source emission data from peaking power plants were temporally allocated based upon operating schedule information provided by MCESD. All point sources which did not have actual operating schedule data available, as well as all area, aviation, and nonroad mobile sources, resolved temporally using default profiles for monthly, day of the week, and diurnal activity patterns.

Job Control Files: tpl.area.co.94.350.bas.job.newwood.nnrd3, tpl.area.co.94.351.bas.job.newwood.nnrd3, tpl.avi.co.94.350.bas.job.98chg.avicor, tpl.avi.co.94.351.bas.job.98chg.avicor, tpl.mvoff.co.94.350.bas.job.nnrd3, tpl.mvoff.co.94.351.bas.job.nnrd3, tpl.pnt.co.94.350.98chg.tj20.job, tpl.pnt.co.94.351.98chg.tj20.job, tpl.area.co.06.350.6%.base.job, tpl.area.co.06.350.fireplace.6%.job, tpl.area.co.06.351.6%.base.job, tpl.area.co.06.351.6%.base.job, tpl.area.co.06.351.fireplace.6%.job, tpl.avi.co.06.350.bas.job, tpl.avi.co.06.351.bas.job, tpl.mvoff.co.06.350.FEDNRi.6%.job, tpl.mvoff.co.06.350.OXYi.6%.job, tpl.mvoff.co.06.350.bas6.job, tpl.mvoff.vo.06.350.cmp6.job, tpl.mvoff.co.06.351.FEDNRi.6%.job, tpl.mvoff.co.06.351.OXYi.6%.job, tpl.mvoff.co.06.351.bas6.job, tpl.mvoff.co.06.351.cmp6.job, tpl.pnt.co_20.06.350.6%.job, tpl.pnt.co_20.06.350.6%.job, tpl.pnt.co_20.06.351.6%.job, tpl.area.co.15.350.fireplace.15%.job.CARB, tpl.area.co.15.351.fireplace.15%.job.CARB, tpl.avi.co.15.350.bas.R2CB.job, tpl.avi.co.15.351.bas.R2CB.job, tpl.mvoff.co.15.350.cm.final.job, tpl.mvoff.co.15.351.cm.final.job, tpl.pnt.co_20.15.350.15%R2.job, tpl.pnt.co_20.15.351.15%R2.job, tpl.area.co.15.350.15%.base.job, tpl.area.co.15.351.15%.base.job, tpl.mvoff.co.15.350.WOcm.final.job, tpl.mvoff.co.15.351.WOcm.final.job, tpl.area.co.15.350.fireplace.15%.job.CARB, tpl.area.co.15.351.fireplace.15%.job.CARB, tpl.mvoff.co.15.350.FEDNR.ind.job, tpl.mvoff.co.15.350.OXY.ind.job, tpl.mvoff.co.15.351.FEDNR.ind.job, tpl.mvoff.co.15.351.OXY.ind.job

GRDEM Module

The GRDEM module was used to spatially allocate emissions. Point sources were located based on the geocoded location of the source provided by MCESD. Area and nonroad mobile source categories were each spatially allocated by surrogate factors which indicate activity by grid cell.

Job Control Files: grd.area.co.94.350.bas.job.newwood.nnrd3, grd.area.co.94.351.bas.job.newwood.nnrd3, grd.avi.co.94.350.bas.job.98chg.avicor, grd.avi.co.94.351.bas.job.98chg.avicor, grd.mvoff.co.94.350.bas.job.nnrd3, grd.mvoff.co.94.351.bas.job.nnrd3, grd.pnt.co.94.350.98chg.tj20.job, grd.pnt.co.94.351.98chg.tj20.job, grd.area.co.06.350.6%.base.job, grd.area.co.06.350.fireplace.6%.job, grd.area.co.06.351.6%.bas.job, grd.area.co.06.351.fireplace.6%.job, grd.avi.co.06.350.bas.job, grd.avi.co.06.351.bas.job, grd.mvoff.co.06.350.FEDNRi.6%.job, grd.mvoff.co.06.350.OXYi.6%.job, grd.mvoff.co.06.350.bas6.job, grd.mvoff.co.06.350.cmp6.job, grd.mvoff.co.06.351.FEDNRi.6%.job, grd.mvoff.co.06.351.OXYi.6%.job, grd.pnt.co_20.06.350.6%.job, grd.pnt.co_20.06.351.6%.job, grd.area.co.15.350.fireplace.15%.CARB.job, grd.area.co.15.351.fireplace.15%.CARB.job, grd.avi.co.15.350.bas.R2CB.job, grd.avi.co.15.351.bas.R2CB.job, grd.mvoff.co.15.350.cm.final.job, grd.mvoff.co.15.351.cm.final.job, grd.pnt.co_20.15.350.15%R2.job, grd.pnt.co_20.15.351.15%R2.job, grd.area.co.15.350.15%.base.job, grd.area.co.15.351.15%.base.job, grd.mvoff.co.15.350.WOcm.final.job, grd.mvoff.co.15.351.WOcm.final.job, grd.area.co.15.350.fireplace.15%.CARB.job, grd.area.co.15.351.fireplace.15%.CARB.job, grd.mvoff.co.15.350.FEDNR.ind.job, grd.mvoff.co.15.350.OXY.ind.job, grd.mvoff.co.15.351.FEDNR.ind.job, grd.mvoff.co.15.351.OXY.ind.job

MRGUAM Module

The MRGUAM module was used to merge the UAM-ready emission files produced by GRDEM for area, nonroad mobile, aviation, and point sources with onroad mobile emissions produced by EXPLORA into a single UAM-ready emission file.

Job Control Files: mrg.co.94.350.bas.job.sd2, mrg.co.94.351.bas.job.sd2, mrg.co.06.350.cmp.R11.job, mrg.co.06.351.cmp.R11.job, mrg.co.15.350.cmp.rev12, mrg.co.15.351.cmp.rev12

Urban Airshed Model (UAM)

The UAM was used to estimate carbon monoxide concentrations. The CO concentrations modeled are hourly and gridded into one square mile cells. The input and output files for the various UAM preprocessors share common directories. The data tape subdirectory for all UAM files is ./uam. The ./uam directory is further divided into four subdirectories. The ./uam/prep subdirectory contains input files and job files for the UAM preprocessors. The ./uam/inputs subdirectory contains the output files from the preprocessors, which are inputs to the UAM core program. The ./uam/run subdirectory contains job files for running the UAM. The ./uam/outputs subdirectory contains the output files from the UAM core program.

Job Control Files: uam06cmpR11.job, uam_15cmpR13.job, uam94base5.job

DIFFBREAK
Data tape subdirectory for the job file: ./uam/prep

The DIFFBREAK file was used to set the heights of mixing layers. The inputs for this preprocessor were calculated using the MIXEMUP package.

Job Control Files: dfbk_alam10up.job

METSCALARS
Data tape subdirectory for the job file: ./uam/prep

The METSCALARS file prepares hourly values for several meteorological scalars. The meteorological values reflect atmospheric water concentrations, pressure, NO_2, photolysis rate, exposure class, and temperature gradients.

Job Control Files: metscl_comt.job

TEMPERATUR
Data tape subdirectory for the job file: ./uam/input

The TEMPERATUR file was not used in the analysis. An empty file named "tt.dum" was created for the UAM core program to process. Temperature data are used to adjust chemical reaction rates in the UAM. The UAM was processed in an inert mode for the study of CO concentrations.

REGIONTOP
Data tape subdirectory for the job file: ./uam/prep

The REGIONTOP file sets the height of the modeling domain. The height of the modeling domain was set to 200 meters for this analysis.

Job Control Files: regntp.job

DIAGNOSTIC WIND MODEL
Data tape subdirectory ./uam/prep/DWM

The Diagnostic Wind Model (DWM) generates wind fields using available observations and terrain data. The output from DWM was input to the UAMWIND preprocessor to produce a UAM-ready wind file.

Job Control Files: dwm1294.job, uamwnd1294.job

UAMWIND PREPROCESSOR
Data tape subdirectory for the job file: ./uam/prep/DWM; Data Tape Subdirectory for Output: ./uam/input

The UAMWIND preprocessor converts the output from the DWM into wind fields which are used in the UAM.

Job Control Files: pre1294.job

AIRQUALITY
Data tape subdirectory for job file: ./uam/prep; Data Tape Subdirectory for Output: ./uam/input

The AIRQUALITY file provides pollutant concentrations to the UAM for the initial hour of the simulation. The initial CO concentrations are based upon available monitoring data.

Job Control Files: airq.job

BOUNDARY
Data tape subdirectory for job file: ./uam/prep; Data Tape Subdirectory for Output: ./uam/input

The BOUNDARY file provides pollutant concentrations to the UAM along the lateral boundaries for the entire simulation period. A constant value of 0.5 ppm was assigned to all lateral boundaries.

Job Control Files: bndr.job

TOPCONC
Data tape subdirectory for job file: ./uam/prep; Data Tape Subdirectory for Output: ./uam/input

The TOPCONC file provides pollutant concentrations to the UAM along the upper boundary for the entire simulation period. A constant value of 0.5 ppm was assigned along the top of the modeling domain.

Job Control Files: topconc.job

TERRAIN
Data tape subdirectory: ./uam/inputs

The surface roughness lengths and deposition factors for the modeling domain are contained in the TERRAIN file for use in deposition calculations. Because no deposition will occur in simulation of CO concentrations, no TERRAIN file was used for this analysis. An empty file named "tn.dum" was created for the UAM core programs to process.

PTSOURCE
Data tape subdirectory for Input: ./eps2/in; Data tape subdirectory for the UAM-ready file: ./uam/inputs

The PTSOURCE files contain emissions from elevated point sources.

Job Control Files: see previous EPS2.0 section for details.

EMISSIONS
Data tape subdirectory for the UAM-ready file: ./uam/inputs

The EMISSIONS files contain merged emissions of all source categories except elevated point sources.

Job Control Files: see previous EPS2.0 section for details.

CHEMPARAM
Data tape subdirectory for job file: ./uam/prep; Data tape subdirectory for Output: ./uam/inputs

The CHEMPARAM file defines CO as the only species in this analysis. Because CO is considered unreactive in the winter season, no reactive properties were defined in CHEMPARAM.

Job Control Files: ch.co.job

Directory structure for the data files.

```
COMaintenan+-> M6Link ----+-> inp -------+-> 1994
           |              |              +-> 2015
           |              |              \-> 2006
           |              |
           |              +-> ctl -------+-> 1994
           |              |              +-> 2015 ------+-> CMP
           |              |              |              +-> IndividualMeasures
           |              |              |              |   IndividualM
           |              |              |              \-> NoMeasures
           |              |              |
           |              |              \-> 2006 ------+-> CMP
           |              +-> out -------+-> 1994 ------+-> M6link1stPortion
           |              |              |                  M6link1stPo
           |              |              +-> 2015 ------+-> IndividualMeasures
           |              |              |              |   IndividualM
           |              |              |              +-> NoMeasures
           |              |              |              +-> M6Link1stPortion
           |              |              |              |   M6Link1stPo
           |              |              |              \-> CMP
           |              |              |
           |              |              \-> 2006
           |              |
           |              \-> medexplora +-> inp -------+-> 1994
           |                             |              +-> 2015
           |                             |              \-> 2006
           |                             |
           |                             +-> job -------+-> 1994
           |                             |              +-> 2015
           |                             |              \-> 2006
           |                             |
           |                             \-> out -------+-> 1994
           |                                            +-> 2015
           |                                            \-> 2006
           |
           +-> MOBILE6 ---+-> forCAL3QHC +-> inp -------+-> 2006
           |              |              |              +-> 1994
           |              |              |              \-> 2015
           |              |              |
           |              |              \-> out -------+-> 2006
           |              |                             +-> 1994
           |              |                             \-> 2015
           |              |
           |              +-> forM6Link -+-> inp -------+-> 1994
           |              |              |              +-> 2015 ------+-> CMP
           |              |              |              |              +-> NoMeasures
           |              |              |              |              \-> IndividualMeasures
           |              |              |              |                  IndividualM+-> Cutpoints
           |              |              |              |                             +-> RFG
           |              |              |              |                             \-> Waivers
           |              |              |              |
           |              |              |              \-> 2006
           |              |              |
           |              |              \-> out -------+-> 1994
           |              |                             +-> 2015 ------+-> IndividualMeasures
           |              |                             |              |   IndividualM+-> Waivers
           |              |                             |              |              +-> RFG
           |              |                             |              |              \-> Cutpoints
           |              |                             |              |
           |              |                             |              +-> NoMeasures
           |              |                             |              \-> CMP
           |              |                             |
           |              |                             \-> 2006
           |              |
           |              \-> forPostProc+-> inp -------+-> CMP
           |                             |              \-> OneMeasure
```

```
|                             |
|                             \-> out -------+-> CMP
|                                            \-> OneMeasure
|
+-> eps2 ------+-> inp -------+-> 1994
|              |              +-> 2015
|              |              +-> 2015_no_measures
|              |              |   2015_no_mea
|              |              +-> 2015_ind_measures
|              |              |   2015_ind_me
|              |              \-> 2006
|              |
|              +-> job -------+-> 2015
|              |              +-> 2006
|              |              +-> 2015_no_measures
|              |              |   2015_no_mea
|              |              +-> 2015_ind_measures
|              |              |   2015_ind_me
|              |              \-> 1994
|              |
|              +-> msg -------+-> 1994
|              |              +-> 2015
|              |              +-> 2015_no_measures
|              |              |   2015_no_mea
|              |              +-> 2015_ind_measures
|              |              |   2015_ind_me
|              |              \-> 2006
|              |
|              \-> out -------+-> 2015
|                             +-> 2015_no_measures
|                             |   2015_no_mea
|                             +-> 2015_ind_measures
|                             |   2015_ind_me
|                             +-> 2006
|                             \-> 1994
|
+-> cal3qhc ---+-> inp -------+-> 1994
|              |              +-> 2015
|              |              \-> 2006
|              |
|              +-> job -------+-> 1994
|              |              +-> 2015
|              |              \-> 2006
|              |
|              \-> out -------+-> 2015
|                             +-> 1994
|                             \-> 2006
|
+-> uam -------+-> run
|              +-> prep ------+-> DFBK
|              |              \-> DWM
|              |
|              +-> outputs ---+-> 1994
|              |              +-> 2015
|              |              \-> 2006
|              |
|              +-> inputs
|              \-> monidata
|
\-> other
```

```
Complete File List:

M6Link
MOBILE6
cal3qhc
dirlist.txt
eps2
filelist.txt
other
uam

./M6Link:
ctl
inp
medexplora
out

./M6Link/ctl:
1994
2006
2015

./M6Link/ctl/1994:
1994COBase.job
Dec1694.ctl
Dec1794.ctl

./M6Link/ctl/2006:
CMP

./M6Link/ctl/2006/CMP:
2006CMPCaseFri.ctl
2006CMPCaseSat.ctl
2006COCMPCase.job
2006COCMPCase.job.NewSpeeds

./M6Link/ctl/2015:
CMP
IndividualMeasures
NoMeasures

./M6Link/ctl/2015/CMP:
2015CMPCase.job.NoCatProgram
2015CMPCaseFriNoCatProgram.ctl
2015CMPCaseSatNoCatProgram.ctl

./M6Link/ctl/2015/IndividualMeasures:
2015COCutpts.job
2015CORFG.job
2015COTougherEnforcement.job
2015COWaivers.job
Dec1615.job.base.rev8.ctl

./M6Link/ctl/2015/NoMeasures:
2015COBase.job
Dec1615.job.base.rev8
Dec1715.job.base.rev8

./M6Link/inp:
1994
2006
2015

./M6Link/inp/1994:
199524.txt
1995_m2xy.dat
1995am.txt
1995md.txt
1995nt.txt
1995pm.txt
AggregateFactors.txt.1994
diurnal.txt
linksplit.txt.Fri.gz
linksplit.txt.Sat.gz

./M6Link/inp/2006:
2006_24h.txt
2006_am.txt
2006_m2xy.dat
2006_md.txt
2006_nt.txt
2006_pm.txt
AggregateFactors.txt.2006
diurnal.txt
linksplit.txt.Fri2006.gz
linksplit.txt.Sat2006.gz

./M6Link/inp/2015:
2015_24h.txt
2015_am.txt
2015_m2xy.dat
2015_md.txt
2015_nt.txt
2015_pm.txt
AggregateFactors.txt.2015
diurnal.txt
linksplit.txt.Fri2015.gz
linksplit.txt.Sat2015.gz

./M6Link/medexplora:
inp
job
out

./M6Link/medexplora/inp:
1994
```

```
2006
2015

./M6Link/medexplora/inp/1994:
chmprf.xref.thc-thc.explora
splitfac.thc.96VEOP
userin.magCO.121615
userin.magCO.121715
userin.med

./M6Link/medexplora/inp/2006:
chmprf.xref.thc-thc.explora
splitfac.thc.96VEOP
userin.magCO.121620
userin.magCO.121720
userin.med

./M6Link/medexplora/inp/2015:
chmprf.xref.thc-thc.explora
splitfac.thc.96VEOP
userin.magCO.121620
userin.magCO.121720
userin.med

./M6Link/medexplora/job:
1994
2006
2015

./M6Link/medexplora/job/1994:
meduam.CO121694.M6Link
meduam.CO121794.M6Link

./M6Link/medexplora/job/2006:
meduam.CO121606.M6Link
meduam.CO121706.M6Link

./M6Link/medexplora/job/2015:
meduam.CO1215.M6Link.rev8
meduam.CO1215.M6Link.rev8.base

./M6Link/medexplora/out:
1994
2006
2015

./M6Link/medexplora/out/1994:
emar.CO121694.M6Link
emar.CO121794.M6Link
msg.CO121694.M6Link
msg.CO121794.M6Link
uam.CO121694.M6Link
uam.CO121794.M6Link

./M6Link/medexplora/out/2006:
uam.CO121606.M6Link.rev11
uam.CO121606.M6Link.rev11.msg
uam.CO121706.M6Link.rev11
uam.CO121706.M6Link.rev11.msg

./M6Link/medexplora/out/2015:
emar.CO121615.M6Link.rev8.BudgetCuts
emar.CO121715.M6Link.rev8.BudgetCuts
emar.COFri15.M6Link.rev8.base
emar.COSat15.M6Link.rev8.base
msg.CO121615.M6Link.rev8.BudgetCuts
msg.CO121715.M6Link.rev8.BudgetCuts
msg.COFri15.M6Link.rev8.base
msg.COSat15.M6Link.rev8.base
uam.CO121615.M6Link.rev8.BudgetCuts
uam.CO121615.M6Link.rev8.BudgetCuts.msg
uam.CO121615.M6Link.rev8.BudgetCuts.new
uam.CO121715.M6Link.rev8.BudgetCuts
uam.CO121715.M6Link.rev8.BudgetCuts.msg
uam.CO121715.M6Link.rev8.BudgetCuts.new
uam.COFri15.M6Link.rev8.base
uam.COFri15.M6Link.rev8.base.new
uam.COSat15.M6Link.rev8.base
uam.COSat15.M6Link.rev8.base.new

./M6Link/out:
1994
2006
2015

./M6Link/out/1994:
M6Link.sm1.1994COBase.Fri
M6Link.sm1.1994COBase.Sat
M6Link.sm2.1994COBase.Fri
M6Link.sm2.1994COBase.Sat
M6Link.sm3.1994COBase.Fri
M6Link.sm3.1994COBase.Sat
M6Link.sm4.1994COBase.Fri
M6Link.sm4.1994COBase.Sat
M6link1stPortion
arcview.txt.1994COBase.Fri
arcview.txt.1994COBase.Sat
crudecharts.txt.1994COBase.Fri
crudecharts.txt.1994COBase.Sat
crudeplots.txt.1994COBase.Fri
crudeplots.txt.1994COBase.Sat
grdms.out.1994COBase.Fri
grdms.out.1994COBase.Sat

./M6Link/out/1994/M6link1stPortion:
m6linkoutfri.zip
m6linkoutsat.zip
```

```
./M6Link/out/2006:
M6Link.sm1.2006CMPCaseFri
M6Link.sm1.2006CMPCaseSat.NewSpeeds
M6Link.sm2.2006CMPCaseFri
M6Link.sm2.2006CMPCaseSat.NewSpeeds
M6Link.sm3.2006CMPCaseFri
M6Link.sm3.2006CMPCaseSat.NewSpeeds
M6Link.sm4.2006CMPCaseFri
M6Link.sm4.2006CMPCaseSat.NewSpeeds
arcview.txt.2006CMPCaseFri
arcview.txt.2006CMPCaseSat.NewSpeeds
crudecharts.txt.2006CMPCaseFri
crudecharts.txt.2006CMPCaseSat.NewSpeeds
crudeplots.txt.2006CMPCaseFri
crudeplots.txt.2006CMPCaseSat.NewSpeeds
grdms.out.2006CMPCaseFri
grdms.out.2006CMPCaseSat.NewSpeeds

./M6Link/out/2015:
CMP
IndividualMeasures
M6Link1stPortion
NoMeasures

./M6Link/out/2015/CMP:
M6Link.sm1.2015CMPCaseFriBudgetCuts
M6Link.sm1.2015CMPCaseSatBudgetCuts
M6Link.sm2.2015CMPCaseFriBudgetCuts
M6Link.sm2.2015CMPCaseSatBudgetCuts
M6Link.sm3.2015CMPCaseFriBudgetCuts
M6Link.sm3.2015CMPCaseSatBudgetCuts
M6Link.sm4.2015CMPCaseFriBudgetCuts
M6Link.sm4.2015CMPCaseSatBudgetCuts
arcview.txt.2015CMPCaseFriBudgetCuts
arcview.txt.2015CMPCaseSatBudgetCuts
crudecharts.txt.2015CMPCaseFriBudgetCuts
crudecharts.txt.2015CMPCaseSatBudgetCuts
crudeplots.txt.2015CMPCaseFriBudgetCuts
crudeplots.txt.2015CMPCaseSatBudgetCuts
grdms.out.2015CMPCaseFriBudgetCuts
grdms.out.2015CMPCaseSatBudgetCuts

./M6Link/out/2015/IndividualMeasures:
M6Link.sm1.2015COCutpts
M6Link.sm1.2015CORFG
M6Link.sm1.2015COTougherEnforcement
M6Link.sm1.2015COWaivers
M6Link.sm2.2015COCutpts
M6Link.sm2.2015CORFG
M6Link.sm2.2015COTougherEnforcement
M6Link.sm2.2015COWaivers
M6Link.sm3.2015COCutpts
M6Link.sm3.2015CORFG
M6Link.sm3.2015COTougherEnforcement
M6Link.sm3.2015COWaivers
M6Link.sm4.2015COCutpts
M6Link.sm4.2015CORFG
M6Link.sm4.2015COTougherEnforcement
M6Link.sm4.2015COWaivers
arcview.txt.2015COCutpts
arcview.txt.2015CORFG
arcview.txt.2015COTougherEnforcement
arcview.txt.2015COWaivers
crudecharts.txt.2015COCutpts
crudecharts.txt.2015CORFG
crudecharts.txt.2015COTougherEnforcement
crudecharts.txt.2015COWaivers
crudeplots.txt.2015COCutpts
crudeplots.txt.2015CORFG
crudeplots.txt.2015COTougherEnforcement
crudeplots.txt.2015COWaivers
grdms.out.2015COCutpts
grdms.out.2015CORFG
grdms.out.2015COTougherEnforcement
grdms.out.2015COWaivers

./M6Link/out/2015/M6Link1stPortion:
m6linkfri.zip
m6linksat.zip

./M6Link/out/2015/NoMeasures:
M6Link.sm1.2015COBase
M6Link.sm2.2015COBase
M6Link.sm3.2015COBase
M6Link.sm4.2015COBase
arcview.txt.2015COBase
crudecharts.txt.2015COBase
crudeplots.txt.2015COBase
grdms.out.2015COBase

./MOBILE6:
forCAL3QHC
forM6Link
forPostProc

./MOBILE6/forCAL3QHC:
inp
out

./MOBILE6/forCAL3QHC/inp:
1994
2006
2015

./MOBILE6/forCAL3QHC/inp/1994:
nD1694A1.in
nD1694A2.in
nD1694A3.in
```

```
nD1694A4.in
nD1694A5.in
wD1694A1.in
wD1694A2.in
wD1694A3.in
wD1694A4.in
wD1694A5.in

./MOBILE6/forCAL3QHC/inp/2006:
99reg06.d
cutpnt06.d
im06mic.in
nim06mic.in
stperday.zer

./MOBILE6/forCAL3QHC/inp/2015:
cutbas15.d
cutpnt15.d
im15mic.in.CMP
im15mic.in.bas
nim15mic.in.CMP
nim15mic.in.bas
stperday.zer
tjreg.d

./MOBILE6/forCAL3QHC/out:
1994
2006
2015

./MOBILE6/forCAL3QHC/out/1994:
ND1694A1.TB1
ND1694A1.TXT
ND1694A2.TB1
ND1694A2.TXT
ND1694A3.TB1
ND1694A3.TXT
ND1694A4.TB1
ND1694A4.TXT
ND1694A5.TB1
ND1694A5.TXT
WD1694A1.TB1
WD1694A1.TXT
WD1694A2.TB1
WD1694A2.TXT
WD1694A3.TB1
WD1694A3.TXT
WD1694A4.TB1
WD1694A4.TXT
WD1694A5.TB1
WD1694A5.TXT

./MOBILE6/forCAL3QHC/out/2006:
IM06MIC.TXT
NIM06MIC.TXT

./MOBILE6/forCAL3QHC/out/2015:
IM15MIC.TXT
NIM15MIC.TXT

./MOBILE6/forM6Link:
inp
out

./MOBILE6/forM6Link/inp:
1994
2006
2015

./MOBILE6/forM6Link/inp/1994:
nD1694A1.in
nD1694A2.in
nD1694A3.in
nD1694A4.in
nD1694A5.in
nD1794A1.in
nD1794A2.in
nD1794A3.in
nD1794A4.in
nD1794A5.in
reg94.txt
svmta1Fr.txt
svmta1Sa.txt
svmta2Fr.txt
svmta2Sa.txt
svmta3Fr.txt
svmta3Sa.txt
svmta4Fr.txt
svmta4Sa.txt
svmta5Fr.txt
svmta5Sa.txt
wD1694A1.in
wD1694A2.in
wD1694A3.in
wD1694A4.in
wD1694A5.in
wD1794A1.in
wD1794A2.in
wD1794A3.in
wD1794A4.in
wD1794A5.in

./MOBILE6/forM6Link/inp/2006:
Nim06A1F.in
Nim06A1S.in
Nim06A2F.in
Nim06A2S.in
Nim06A3F.in
```

```
Nim06A3S.in
Nim06A4F.in
Nim06A4S.in
Nim06A5F.in
Nim06A5S.in
cutpnt06.d
im06A1F.in
im06A1S.in
im06A2F.in
im06A2S.in
im06A3F.in
im06A3S.in
im06A4F.in
im06A4S.in
im06A5F.in
im06A5S.in
svmta1FR.txt
svmta1Sa.new
svmta2FR.txt
svmta2Sa.new
svmta3FR.txt
svmta3Sa.new
svmta4FR.txt
svmta4Sa.new
svmta5FR.txt
svmta5Sa.new

./MOBILE6/forM6Link/inp/2015:
CMP
IndividualMeasures
NoMeasures
cutpnt15.d
svmta1Fr.txt
svmta1Sa.txt
svmta2Fr.txt
svmta2Sa.txt
svmta3Fr.txt
svmta3Sa.txt
svmta4Fr.txt
svmta4Sa.txt
svmta5Fr.txt
svmta5Sa.txt

./MOBILE6/forM6Link/inp/2015/CMP:
Nim15A1F.in
Nim15A1S.in
Nim15A2F.in
Nim15A2S.in
Nim15A3F.in
Nim15A3S.in
Nim15A4F.in
Nim15A4S.in
Nim15A5F.in
Nim15A5S.in
cutpnt15.d
im15A1F.in
im15A1S.in
im15A2F.in
im15A2S.in
im15A3F.in
im15A3S.in
im15A4F.in
im15A4S.in
im15A5F.in
im15A5S.in

./MOBILE6/forM6Link/inp/2015/IndividualMeasur
es:
Cutpoints
RFG
Waivers

./MOBILE6/forM6Link/inp/2015/IndividualMeasur
es/Cutpoints:
Nim15A1F.in
Nim15A2F.in
Nim15A3F.in
Nim15A4F.in
Nim15A5F.in
cutbas15.d
im15A1F.in
im15A2F.in
im15A3F.in
im15A4F.in
im15A5F.in

./MOBILE6/forM6Link/inp/2015/IndividualMeasur
es/RFG:
Nim15A1F.in
Nim15A2F.in
Nim15A3F.in
Nim15A4F.in
Nim15A5F.in
im15A1F.in
im15A2F.in
im15A3F.in
im15A4F.in
im15A5F.in

./MOBILE6/forM6Link/inp/2015/IndividualMeasur
es/Waivers:
Nim15A1F.in
Nim15A2F.in
Nim15A3F.in
Nim15A4F.in
Nim15A5F.in
im15A1F.in
im15A2F.in
```

```
im15A3F.in
im15A4F.in
im15A5F.in

./MOBILE6/forM6Link/inp/2015/NoMeasures:
Nim15A1F.in
Nim15A2F.in
Nim15A3F.in
Nim15A4F.in
Nim15A5F.in
cutbas15.d
im15A1F.in
im15A2F.in
im15A3F.in
im15A4F.in
im15A5F.in

./MOBILE6/forM6Link/out:
1994
2006
2015

./MOBILE6/forM6Link/out/1994:
ND1694A1.TB1
ND1694A1.TXT
ND1694A2.TB1
ND1694A2.TXT
ND1694A3.TB1
ND1694A3.TXT
ND1694A4.TB1
ND1694A4.TXT
ND1694A5.TB1
ND1694A5.TXT
ND1794A1.TB1
ND1794A1.TXT
ND1794A2.TB1
ND1794A2.TXT
ND1794A3.TB1
ND1794A3.TXT
ND1794A4.TB1
ND1794A4.TXT
ND1794A5.TB1
ND1794A5.TXT
WD1694A1.TB1
WD1694A1.TXT
WD1694A2.TB1
WD1694A2.TXT
WD1694A3.TB1
WD1694A3.TXT
WD1694A4.TB1
WD1694A4.TXT
WD1694A5.TB1
WD1694A5.TXT
WD1794A1.TB1
WD1794A1.TXT
WD1794A2.TB1
WD1794A2.TXT
WD1794A3.TB1
WD1794A3.TXT
WD1794A4.TB1
WD1794A4.TXT
WD1794A5.TB1
WD1794A5.TXT

./MOBILE6/forM6Link/out/2006:
IM06A1F.TB1
IM06A1F.TXT
IM06A1S.TB1
IM06A1S.TXT
IM06A2F.TB1
IM06A2F.TXT
IM06A2S.TB1
IM06A2S.TXT
IM06A3F.TB1
IM06A3F.TXT
IM06A3S.TB1
IM06A3S.TXT
IM06A4F.TB1
IM06A4F.TXT
IM06A4S.TB1
IM06A4S.TXT
IM06A5F.TB1
IM06A5F.TXT
IM06A5S.TB1
IM06A5S.TXT
NIM06A1F.TB1
NIM06A1F.TXT
NIM06A1S.TB1
NIM06A1S.TXT
NIM06A2F.TB1
NIM06A2F.TXT
NIM06A2S.TB1
NIM06A2S.TXT
NIM06A3F.TB1
NIM06A3F.TXT
NIM06A3S.TB1
NIM06A3S.TXT
NIM06A4F.TB1
NIM06A4F.TXT
NIM06A4S.TB1
NIM06A4S.TXT
NIM06A5F.TB1
NIM06A5F.TXT
NIM06A5S.TB1
NIM06A5S.TXT

./MOBILE6/forM6Link/out/2015:
CMP
```

```
IndividualMeasures
NoMeasures

./MOBILE6/forM6Link/out/2015/CMP:
IM15A1F.TB1
IM15A1F.TXT
IM15A1S.TB1
IM15A1S.TXT
IM15A2F.TB1
IM15A2F.TXT
IM15A2S.TB1
IM15A2S.TXT
IM15A3F.TB1
IM15A3F.TXT
IM15A3S.TB1
IM15A3S.TXT
IM15A4F.TB1
IM15A4F.TXT
IM15A4S.TB1
IM15A4S.TXT
IM15A5F.TB1
IM15A5F.TXT
IM15A5S.TB1
IM15A5S.TXT
NIM15A1F.TB1
NIM15A1F.TXT
NIM15A1S.TB1
NIM15A1S.TXT
NIM15A2F.TB1
NIM15A2F.TXT
NIM15A2S.TB1
NIM15A2S.TXT
NIM15A3F.TB1
NIM15A3F.TXT
NIM15A3S.TB1
NIM15A3S.TXT
NIM15A4F.TB1
NIM15A4F.TXT
NIM15A4S.TB1
NIM15A4S.TXT
NIM15A5F.TB1
NIM15A5F.TXT
NIM15A5S.TB1
NIM15A5S.TXT

./MOBILE6/forM6Link/out/2015/IndividualMeasur
es:
Cutpoints
RFG
Waivers

./MOBILE6/forM6Link/out/2015/IndividualMeasur
es/Cutpoints:
IM15A1F.TB1
IM15A1F.TXT
IM15A2F.TB1
IM15A2F.TXT
IM15A3F.TB1
IM15A3F.TXT
IM15A4F.TB1
IM15A4F.TXT
IM15A5F.TB1
IM15A5F.TXT
NIM15A1F.TB1
NIM15A1F.TXT
NIM15A2F.TB1
NIM15A2F.TXT
NIM15A3F.TB1
NIM15A3F.TXT
NIM15A4F.TB1
NIM15A4F.TXT
NIM15A5F.TB1
NIM15A5F.TXT

./MOBILE6/forM6Link/out/2015/IndividualMeasur
es/RFG:
IM15A1F.TB1
IM15A1F.TXT
IM15A2F.TB1
IM15A2F.TXT
IM15A3F.TB1
IM15A3F.TXT
IM15A4F.TB1
IM15A4F.TXT
IM15A5F.TB1
IM15A5F.TXT
NIM15A1F.TB1
NIM15A1F.TXT
NIM15A2F.TB1
NIM15A2F.TXT
NIM15A3F.TB1
NIM15A3F.TXT
NIM15A4F.TB1
NIM15A4F.TXT
NIM15A5F.TB1
NIM15A5F.TXT

./MOBILE6/forM6Link/out/2015/IndividualMeasur
es/Waivers:
IM15A1F.TB1
IM15A1F.TXT
IM15A2F.TB1
IM15A2F.TXT
IM15A3F.TB1
IM15A3F.TXT
IM15A4F.TB1
IM15A4F.TXT
IM15A5F.TB1
```

```
IM15A5F.TXT
NIM15A1F.TB1
NIM15A1F.TXT
NIM15A2F.TB1
NIM15A2F.TXT
NIM15A3F.TB1
NIM15A3F.TXT
NIM15A4F.TB1
NIM15A4F.TXT
NIM15A5F.TB1
NIM15A5F.TXT

./MOBILE6/forM6Link/out/2015/NoMeasures:
IM15A1F.TB1
IM15A1F.TXT
IM15A2F.TB1
IM15A2F.TXT
IM15A3F.TB1
IM15A3F.TXT
IM15A4F.TB1
IM15A4F.TXT
IM15A5F.TB1
IM15A5F.TXT
NIM15A1F.TB1
NIM15A1F.TXT
NIM15A2F.TB1
NIM15A2F.TXT
NIM15A3F.TB1
NIM15A3F.TXT
NIM15A4F.TB1
NIM15A4F.TXT
NIM15A5F.TB1
NIM15A5F.TXT

./MOBILE6/forPostProc:
inp
out

./MOBILE6/forPostProc/inp:
CMP
OneMeasure

./MOBILE6/forPostProc/inp/CMP:
Nim06ITS.in
im06ITS.in
im15PP.in
nim15PP.in

./MOBILE6/forPostProc/inp/OneMeasure:
im15PP.in
nim15PP.in

./MOBILE6/forPostProc/out:
CMP
OneMeasure

./MOBILE6/forPostProc/out/CMP:
IM06ITS.TXT
IM15PP.TXT
NIM06ITS.TXT
NIM15PP.TXT

./MOBILE6/forPostProc/out/OneMeasure:
IM15PP.TXT
NIM15PP.TXT

./cal3qhc:
inp
job
out

./cal3qhc/inp:
1994
2006
2015

./cal3qhc/inp/1994:
c1_0194i.dat
c1_0194t.dat
c1_0294i.dat
c1_0294t.dat
c1_0394i.dat
c1_0394t.dat
c1_0494i.dat
c1_0494t.dat
c1_0594i.dat
c1_0594t.dat
c1_0694i.dat
c1_0694t.dat
c1_0794i.dat
c1_0794t.dat
c1_0894i.dat
c1_0894t.dat
c1_0994i.dat
c1_0994t.dat
c1_1094i.dat
c1_1094t.dat
c1_1194i.dat
c1_1194t.dat
c1_1294i.dat
c1_1294t.dat
c1_1394i.dat
c1_1394t.dat
c1_1494i.dat
c1_1494t.dat
c1_1594i.dat
c1_1594t.dat
c1_1694i.dat
```

```
c1_1694t.dat
c1_1794i.dat
c1_1794t.dat
c1_1894i.dat
c1_1894t.dat
c1_1994i.dat
c1_1994t.dat
c1_2094i.dat
c1_2094t.dat
c1_2194i.dat
c1_2194t.dat
c1_2294i.dat
c1_2294t.dat
c1_2394i.dat
c1_2394t.dat
c1_2494i.dat
c1_2494t.dat
c2_0194i.dat
c2_0194t.dat
c2_0294i.dat
c2_0294t.dat
c2_0394i.dat
c2_0394t.dat
c2_0494i.dat
c2_0494t.dat
c2_0594i.dat
c2_0594t.dat
c2_0694i.dat
c2_0694t.dat
c2_0794i.dat
c2_0794t.dat
c2_0894i.dat
c2_0894t.dat
c2_0994i.dat
c2_0994t.dat
c2_1094i.dat
c2_1094t.dat
c2_1194i.dat
c2_1194t.dat
c2_1294i.dat
c2_1294t.dat
c2_1394i.dat
c2_1394t.dat
c2_1494i.dat
c2_1494t.dat
c2_1594i.dat
c2_1594t.dat
c2_1694i.dat
c2_1694t.dat
c2_1794i.dat
c2_1794t.dat
c2_1894i.dat
c2_1894t.dat
c2_1994i.dat
c2_1994t.dat
c2_2094i.dat
c2_2094t.dat
c2_2194i.dat
c2_2194t.dat
c2_2294i.dat
c2_2294t.dat
c2_2394i.dat
c2_2394t.dat
c2_2494i.dat
c2_2494t.dat
c3_0194i.dat
c3_0294i.dat
c3_0394i.dat
c3_0494i.dat
c3_0594i.dat
c3_0694i.dat
c3_0794i.dat
c3_0894i.dat
c3_0994i.dat
c3_1094i.dat
c3_1194i.dat
c3_1294i.dat
c3_1394i.dat
c3_1494i.dat
c3_1594i.dat
c3_1694i.dat
c3_1794i.dat
c3_1894i.dat
c3_1994i.dat
c3_2094i.dat
c3_2194i.dat
c3_2294i.dat
c3_2394i.dat
c3_2494i.dat

./cal3qhc/inp/2006:
ii_a_01.dat
ii_a_02.dat
ii_a_03.dat
ii_a_04.dat
ii_a_05.dat
ii_a_06.dat
ii_a_07.dat
ii_a_08.dat
ii_a_09.dat
ii_a_10.dat
ii_a_11.dat
ii_a_12.dat
ii_a_13.dat
ii_a_14.dat
ii_a_15.dat
ii_a_16.dat
ii_a_17.dat
```

```
ii_a_18.dat
ii_a_19.dat
ii_a_20.dat
ii_a_21.dat
ii_a_22.dat
ii_a_23.dat
ii_a_24.dat
ii_b_01.dat
ii_b_02.dat
ii_b_03.dat
ii_b_04.dat
ii_b_05.dat
ii_b_06.dat
ii_b_07.dat
ii_b_08.dat
ii_b_09.dat
ii_b_10.dat
ii_b_11.dat
ii_b_12.dat
ii_b_13.dat
ii_b_14.dat
ii_b_15.dat
ii_b_16.dat
ii_b_17.dat
ii_b_18.dat
ii_b_19.dat
ii_b_20.dat
ii_b_21.dat
ii_b_22.dat
ii_b_23.dat
ii_b_24.dat
ii_c_01.dat
ii_c_02.dat
ii_c_03.dat
ii_c_04.dat
ii_c_05.dat
ii_c_06.dat
ii_c_07.dat
ii_c_08.dat
ii_c_09.dat
ii_c_10.dat
ii_c_11.dat
ii_c_12.dat
ii_c_13.dat
ii_c_14.dat
ii_c_15.dat
ii_c_16.dat
ii_c_17.dat
ii_c_18.dat
ii_c_19.dat
ii_c_20.dat
ii_c_21.dat
ii_c_22.dat
ii_c_23.dat
ii_c_24.dat
ti_a_01.dat
ti_a_02.dat
ti_a_03.dat
ti_a_04.dat
ti_a_05.dat
ti_a_06.dat
ti_a_07.dat
ti_a_08.dat
ti_a_09.dat
ti_a_10.dat
ti_a_11.dat
ti_a_12.dat
ti_a_13.dat
ti_a_14.dat
ti_a_15.dat
ti_a_16.dat
ti_a_17.dat
ti_a_18.dat
ti_a_19.dat
ti_a_20.dat
ti_a_21.dat
ti_a_22.dat
ti_a_23.dat
ti_a_24.dat
ti_b_01.dat
ti_b_02.dat
ti_b_03.dat
ti_b_04.dat
ti_b_05.dat
ti_b_06.dat
ti_b_07.dat
ti_b_08.dat
ti_b_09.dat
ti_b_10.dat
ti_b_11.dat
ti_b_12.dat
ti_b_13.dat
ti_b_14.dat
ti_b_15.dat
ti_b_16.dat
ti_b_17.dat
ti_b_18.dat
ti_b_19.dat
ti_b_20.dat
ti_b_21.dat
ti_b_22.dat
ti_b_23.dat
ti_b_24.dat

./cal3qhc/inp/2015:
ia_a_01.dat
ia_a_02.dat
ia_a_03.dat
```

ia_a_04.dat
ia_a_05.dat
ia_a_06.dat
ia_a_07.dat
ia_a_08.dat
ia_a_09.dat
ia_a_10.dat
ia_a_11.dat
ia_a_12.dat
ia_a_13.dat
ia_a_14.dat
ia_a_15.dat
ia_a_16.dat
ia_a_17.dat
ia_a_18.dat
ia_a_19.dat
ia_a_20.dat
ia_a_21.dat
ia_a_22.dat
ia_a_23.dat
ia_a_24.dat
ia_b_01.dat
ia_b_02.dat
ia_b_03.dat
ia_b_04.dat
ia_b_05.dat
ia_b_06.dat
ia_b_07.dat
ia_b_08.dat
ia_b_09.dat
ia_b_10.dat
ia_b_11.dat
ia_b_12.dat
ia_b_13.dat
ia_b_14.dat
ia_b_15.dat
ia_b_16.dat
ia_b_17.dat
ia_b_18.dat
ia_b_19.dat
ia_b_20.dat
ia_b_21.dat
ia_b_22.dat
ia_b_23.dat
ia_b_24.dat
ia_c_01.dat
ia_c_02.dat
ia_c_03.dat
ia_c_04.dat
ia_c_05.dat
ia_c_06.dat
ia_c_07.dat
ia_c_08.dat
ia_c_09.dat
ia_c_10.dat
ia_c_11.dat
ia_c_12.dat
ia_c_13.dat
ia_c_14.dat
ia_c_15.dat
ia_c_16.dat
ia_c_17.dat
ia_c_18.dat
ia_c_19.dat
ia_c_20.dat
ia_c_21.dat
ia_c_22.dat
ia_c_23.dat
ia_c_24.dat
ta_a_01.dat
ta_a_02.dat
ta_a_03.dat
ta_a_04.dat
ta_a_05.dat
ta_a_06.dat
ta_a_07.dat
ta_a_08.dat
ta_a_09.dat
ta_a_10.dat
ta_a_11.dat
ta_a_12.dat
ta_a_13.dat
ta_a_14.dat
ta_a_15.dat
ta_a_16.dat
ta_a_17.dat
ta_a_18.dat
ta_a_19.dat
ta_a_20.dat
ta_a_21.dat
ta_a_22.dat
ta_a_23.dat
ta_a_24.dat
ta_b_01.dat
ta_b_02.dat
ta_b_03.dat
ta_b_04.dat
ta_b_05.dat
ta_b_06.dat
ta_b_07.dat
ta_b_08.dat
ta_b_09.dat
ta_b_10.dat
ta_b_11.dat
ta_b_12.dat
ta_b_13.dat
ta_b_14.dat
ta_b_15.dat

```
ta_b_16.dat
ta_b_17.dat
ta_b_18.dat
ta_b_19.dat
ta_b_20.dat
ta_b_21.dat
ta_b_22.dat
ta_b_23.dat
ta_b_24.dat

./cal3qhc/job:
1994
2006
2015

./cal3qhc/job/1994:
1994.job
2000.job
2010.job

./cal3qhc/job/2006:
cal3qhc.job1.Mar13_03.isr
cal3qhc.job1.Mar13_03.tms
cal3qhc.job2.Mar13_03.isr
cal3qhc.job2.Mar13_03.tms
cal3qhc.job3.Mar13_03.isr

./cal3qhc/job/2015:
cal3qhc.job1.Jan29_03.isr
cal3qhc.job1.Jan29_03.tms
cal3qhc.job2.Jan29_03.isr
cal3qhc.job2.Jan29_03.tms
cal3qhc.job3.Jan29_03.isr

./cal3qhc/out:
1994
2006
2015

./cal3qhc/out/1994:
c1_0194i.out
c1_0194t.out
c1_0294i.out
c1_0294t.out
c1_0394i.out
c1_0394t.out
c1_0494i.out
c1_0494t.out
c1_0594i.out
c1_0594t.out
c1_0694i.out
c1_0694t.out
c1_0794i.out
c1_0794t.out
c1_0894i.out
c1_0894t.out
c1_0994i.out
c1_0994t.out
c1_1094i.out
c1_1094t.out
c1_1194i.out
c1_1194t.out
c1_1294i.out
c1_1294t.out
c1_1394i.out
c1_1394t.out
c1_1494i.out
c1_1494t.out
c1_1594i.out
c1_1594t.out
c1_1694i.out
c1_1694t.out
c1_1794i.out
c1_1794t.out
c1_1894i.out
c1_1894t.out
c1_1994i.out
c1_1994t.out
c1_2094i.out
c1_2094t.out
c1_2194i.out
c1_2194t.out
c1_2294i.out
c1_2294t.out
c1_2394i.out
c1_2394t.out
c1_2494i.out
c1_2494t.out
c2_0194i.out
c2_0194t.out
c2_0294i.out
c2_0294t.out
c2_0394i.out
c2_0394t.out
c2_0494i.out
c2_0494t.out
c2_0594i.out
c2_0594t.out
c2_0694i.out
c2_0694t.out
c2_0794i.out
c2_0794t.out
c2_0894i.out
c2_0894t.out
c2_0994i.out
c2_0994t.out
c2_1094i.out
c2_1094t.out
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c2_1194i.out
c2_1194t.out
c2_1294i.out
c2_1294t.out
c2_1394i.out
c2_1394t.out
c2_1494i.out
c2_1494t.out
c2_1594i.out
c2_1594t.out
c2_1694i.out
c2_1694t.out
c2_1794i.out
c2_1794t.out
c2_1894i.out
c2_1894t.out
c2_1994i.out
c2_1994t.out
c2_2094i.out
c2_2094t.out
c2_2194i.out
c2_2194t.out
c2_2294i.out
c2_2294t.out
c2_2394i.out
c2_2394t.out
c2_2494i.out
c2_2494t.out
c3_0194i.out
c3_0294i.out
c3_0394i.out
c3_0494i.out
c3_0594i.out
c3_0694i.out
c3_0794i.out
c3_0894i.out
c3_0994i.out
c3_1094i.out
c3_1194i.out
c3_1294i.out
c3_1394i.out
c3_1494i.out
c3_1594i.out
c3_1694i.out
c3_1794i.out
c3_1894i.out
c3_1994i.out
c3_2094i.out
c3_2194i.out
c3_2294i.out
c3_2394i.out
c3_2494i.out

./cal3qhc/out/2006:
ii_a_01.out
ii_a_02.out
ii_a_03.out
ii_a_04.out
ii_a_05.out
ii_a_06.out
ii_a_07.out
ii_a_08.out
ii_a_09.out
ii_a_10.out
ii_a_11.out
ii_a_12.out
ii_a_13.out
ii_a_14.out
ii_a_15.out
ii_a_16.out
ii_a_17.out
ii_a_18.out
ii_a_19.out
ii_a_20.out
ii_a_21.out
ii_a_22.out
ii_a_23.out
ii_a_24.out
ii_b_01.out
ii_b_02.out
ii_b_03.out
ii_b_04.out
ii_b_05.out
ii_b_06.out
ii_b_07.out
ii_b_08.out
ii_b_09.out
ii_b_10.out
ii_b_11.out
ii_b_12.out
ii_b_13.out
ii_b_14.out
ii_b_15.out
ii_b_16.out
ii_b_17.out
ii_b_18.out
ii_b_19.out
ii_b_20.out
ii_b_21.out
ii_b_22.out
ii_b_23.out
ii_b_24.out
ii_c_01.out
ii_c_02.out
ii_c_03.out
ii_c_04.out
ii_c_05.out
ii_c_06.out
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ii_c_07.out
ii_c_08.out
ii_c_09.out
ii_c_10.out
ii_c_11.out
ii_c_12.out
ii_c_13.out
ii_c_14.out
ii_c_15.out
ii_c_16.out
ii_c_17.out
ii_c_18.out
ii_c_19.out
ii_c_20.out
ii_c_21.out
ii_c_22.out
ii_c_23.out
ii_c_24.out
ti_a_01.out
ti_a_02.out
ti_a_03.out
ti_a_04.out
ti_a_05.out
ti_a_06.out
ti_a_07.out
ti_a_08.out
ti_a_09.out
ti_a_10.out
ti_a_11.out
ti_a_12.out
ti_a_13.out
ti_a_14.out
ti_a_15.out
ti_a_16.out
ti_a_17.out
ti_a_18.out
ti_a_19.out
ti_a_20.out
ti_a_21.out
ti_a_22.out
ti_a_23.out
ti_a_24.out
ti_b_01.out
ti_b_02.out
ti_b_03.out
ti_b_04.out
ti_b_05.out
ti_b_06.out
ti_b_07.out
ti_b_08.out
ti_b_09.out
ti_b_10.out
ti_b_11.out
ti_b_12.out
ti_b_13.out
ti_b_14.out
ti_b_15.out
ti_b_16.out
ti_b_17.out
ti_b_18.out
ti_b_19.out
ti_b_20.out
ti_b_21.out
ti_b_22.out
ti_b_23.out
ti_b_24.out

./cal3qhc/out/2015:
ia_a_01.out
ia_a_02.out
ia_a_03.out
ia_a_04.out
ia_a_05.out
ia_a_06.out
ia_a_07.out
ia_a_08.out
ia_a_09.out
ia_a_10.out
ia_a_11.out
ia_a_12.out
ia_a_13.out
ia_a_14.out
ia_a_15.out
ia_a_16.out
ia_a_17.out
ia_a_18.out
ia_a_19.out
ia_a_20.out
ia_a_21.out
ia_a_22.out
ia_a_23.out
ia_a_24.out
ia_b_01.out
ia_b_02.out
ia_b_03.out
ia_b_04.out
ia_b_05.out
ia_b_06.out
ia_b_07.out
ia_b_08.out
ia_b_09.out
ia_b_10.out
ia_b_11.out
ia_b_12.out
ia_b_13.out
ia_b_14.out
ia_b_15.out
ia_b_16.out
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ia_b_17.out
ia_b_18.out
ia_b_19.out
ia_b_20.out
ia_b_21.out
ia_b_22.out
ia_b_23.out
ia_b_24.out
ia_c_01.out
ia_c_02.out
ia_c_03.out
ia_c_04.out
ia_c_05.out
ia_c_06.out
ia_c_07.out
ia_c_08.out
ia_c_09.out
ia_c_10.out
ia_c_11.out
ia_c_12.out
ia_c_13.out
ia_c_14.out
ia_c_15.out
ia_c_16.out
ia_c_17.out
ia_c_18.out
ia_c_19.out
ia_c_20.out
ia_c_21.out
ia_c_22.out
ia_c_23.out
ia_c_24.out
ta_a_01.out
ta_a_02.out
ta_a_03.out
ta_a_04.out
ta_a_05.out
ta_a_06.out
ta_a_07.out
ta_a_08.out
ta_a_09.out
ta_a_10.out
ta_a_11.out
ta_a_12.out
ta_a_13.out
ta_a_14.out
ta_a_15.out
ta_a_16.out
ta_a_17.out
ta_a_18.out
ta_a_19.out
ta_a_20.out
ta_a_21.out
ta_a_22.out
ta_a_23.out
ta_a_24.out
ta_b_01.out
ta_b_02.out
ta_b_03.out
ta_b_04.out
ta_b_05.out
ta_b_06.out
ta_b_07.out
ta_b_08.out
ta_b_09.out
ta_b_10.out
ta_b_11.out
ta_b_12.out
ta_b_13.out
ta_b_14.out
ta_b_15.out
ta_b_16.out
ta_b_17.out
ta_b_18.out
ta_b_19.out
ta_b_20.out
ta_b_21.out
ta_b_22.out
ta_b_23.out
ta_b_24.out

./eps2:
inp
job
msg
out

./eps2/inp:
1994
2006
2015
2015_ind_measures
2015_no_measures

./eps2/inp/1994:
afs.co.94.350.98chg
afs.co.94.351.98chg
ams.co.93.pei.annual
chmprf.xref.thc-voc.v0393.magco
cosurnew
ctl.factors.ams.co.94.avicor
ctl.factors.ams.co.94.bas.fuel.new
ctl.factors.ams.co.94.bas.new
ctl.factors.ams.co.94.bas.nrdadj
ctl.factors.ams.co.94.bas.ratio
links.airp.phx.new
links.co.94.350.bas
links.co.94.351.bas
```

```
madjin.pream.splits
mdum2
newsurrogate
sicasc.glsry.v0393
splitfac.thc-voc
srgfac.xref.v0393.magco.new
srgfac.xref.v0393.magco.new1
tpl.prof.xref.co.93.350.point
tpl.prof.xref.co.93.351.point
tpl.prof.xref.co.93.area
tpl.prof.xref.co.93.area.nnrd2
tpl.profiles.co.93
tpl.profiles.co.93.nnrd1
userin.co.94.350
userin.co.94.350.tj
userin.co.94.351
userin.co.94.351.tj

./eps2/inp/2006:
afs.co.PC.06.6%
ams.CO.99.activity.bas.final
chmprf.xref.v0199.magco
cosurnew
ctl.factors.ams.co.06.6%GF.bas
ctl.factors.ams.co.06.bas
ctl.factors.ams.co.06.bas.fuel
ctl.factors.ams.co.06.cmp.fuel
ctl.factors.ams.co.06.fireplace
ctl.factors.ams.co.06.nrdmeas
ctl.factors.lbas.co.06.avi
link.bas.CO.121699
link.bas.CO.121799
links.airp.phx.new
madjin.pream.splits
phx.gdsurg.new
sicasc.glsry.v0393
splitfac.thc-voc
srgfac.xref.v0400.new
tpl.prof.xref.co.93.area.nnrd2.cmp
tpl.profile.CO.06.bas.final.sd
tpl.profiles.co.93.nnrd1.cmp
tpl.xref.CO.06.bas.final.sd.act
userin.co.06.350
userin.co.06.351
userin.co.avi.06.350
userin.co.avi.06.351
userin.co_20.06.350
userin.co_20.06.351

./eps2/inp/2015:
afs.co.PC.15.15%
ams.CO.99.activity.bas.final
chmprf.xref.v0199.magco
cosurnew
ctl.factors.R2.lbas.co.15.avi
ctl.factors.ams.co.15.15%GF.bas
ctl.factors.ams.co.15.WOcm.fuel
ctl.factors.ams.co.15.bas
ctl.factors.ams.co.15.bas.fuel
ctl.factors.ams.co.15.fireplace
ctl.factors.ams.co.15.nrdmeas
links.airp.phx.new
madjin.pream.splits
sicasc.glsry.v0393
splitfac.thc-voc
srgfac.xref.v0400.new
tpl.prof.xref.co.93.area.nnrd2.cmp
tpl.profile.CO.06.bas.final.sd
tpl.profiles.co.93.nnrd1.cmp
tpl.xref.CO.06.bas.final.sd.act
userin.co.06.350
userin.co.06.351
userin.co.15.350
userin.co.15.351
userin.co.avi.99.350
userin.co.avi.99.351
userin.co_20.15.350
userin.co_20.15.351

./eps2/inp/2015_ind_measures:

./eps2/inp/2015_no_measures:
ams.CO.99.activity.bas.final
chmprf.xref.v0199.magco
cosurnew
ctl.factors.ams.co.15.15%GF.bas
ctl.factors.ams.co.15.WOcm.fuel
ctl.factors.ams.co.15.bas
links.airp.phx.new
madjin.pream.splits
sicasc.glsry.v0393
splitfac.thc-voc
srgfac.xref.v0400.new
tpl.prof.xref.co.93.area.nnrd2.cmp
tpl.profiles.co.93.nnrd1.cmp
userin.co.06.350
userin.co.06.351
userin.co.15.350
userin.co.15.351

./eps2/job:
1994
2006
2015
2015_ind_measures
2015_no_measures

./eps2/job/1994:
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```
chm.area.co.94.350.bas.job.nnrd3
chm.area.co.94.351.bas.job.nnrd3
chm.avi.co.94.350.bas.job.98chg.avicor
chm.avi.co.94.351.bas.job.98chg.avicor
chm.mvoff.co.94.350.bas.job.nnrd3
chm.mvoff.co.94.351.bas.job.nnrd3
chm.pnt.co.94.350.98chg.tj20.job
chm.pnt.co.94.351.98chg.tj20.job
ctl.area.co.94.350.bas.job.nnrd3
ctl.area.co.94.351.bas.job.nnrd3
ctl.avi.co.94.350.bas.job.98chg.avicor
ctl.avi.co.94.351.bas.job.98chg.avicor
ctl.mvoff.co.94.350.bas.adj.job.nnrd3
ctl.mvoff.co.94.350.bas.job.nnrd3
ctl.mvoff.co.94.350.bas.ratio.job.nnrd3
ctl.mvoff.co.94.350.bas.reduce.job.nnrd3
ctl.mvoff.co.94.351.bas.adj.job.nnrd3
ctl.mvoff.co.94.351.bas.job.nnrd3
ctl.mvoff.co.94.351.bas.ratio.job.nnrd3
ctl.mvoff.co.94.351.bas.reduce.job.nnrd3
grd.area.co.94.350.bas.job.newwood.nnrd3
grd.area.co.94.351.bas.job.newwood.nnrd3
grd.avi.co.94.350.bas.job.98chg.avicor
grd.avi.co.94.351.bas.job.98chg.avicor
grd.mvoff.co.94.350.bas.job.nnrd3
grd.mvoff.co.94.351.bas.job.nnrd3
grd.pnt.co.94.350.98chg.tj20.job
grd.pnt.co.94.351.98chg.tj20.job
lbs.co.94.350.bas.job.98chg
lbs.co.94.351.bas.job.98chg
mrg.co.94.350.bas.job.sd2
mrg.co.94.351.bas.job.sd2
pra.co.94.350.bas.job.nnrd3
pra.co.94.351.bas.job.nnrd3
prp.pnt.co.94.350.98chg.tj20.job
prp.pnt.co.94.351.98chg.tj20.job
pst.pnt.co.94.350.tj20.job
pst.pnt.co.94.351.tj20.job
tpl.area.co.94.350.bas.job.newwood.nnrd3
tpl.area.co.94.351.bas.job.newwood.nnrd3
tpl.avi.co.94.350.bas.job.98chg.avicor
tpl.avi.co.94.351.bas.job.98chg.avicor
tpl.mvoff.co.94.350.bas.job.nnrd3
tpl.mvoff.co.94.351.bas.job.nnrd3
tpl.pnt.co.94.350.98chg.tj20.job
tpl.pnt.co.94.351.98chg.tj20.job

./eps2/job/2006:
chm.area.co.06.350.6%.base.job
chm.area.co.06.350.fireplace.6%.job
chm.area.co.06.351.6%.base.job
chm.area.co.06.351.fireplace.6%.job
chm.avi.co.06.350.base.job
chm.avi.co.06.351.base.job
chm.mvoff.co.06.350.6%bas.job
chm.mvoff.co.06.350.FEDNRi.6%.job
chm.mvoff.co.06.350.OXYi.6%.job
chm.mvoff.co.06.350.cmp6.job
chm.mvoff.co.06.351.6%bas.job
chm.mvoff.co.06.351.FEDNRi.6%.job
chm.mvoff.co.06.351.OXYi.6%.job
chm.mvoff.co.06.351.cmp6.job
chm.pnt.co_20.06.350.6%.job
chm.pnt.co_20.06.351.6%.job
ctl.area.co.06.350.6%.job
ctl.area.co.06.350.fireplace.6%.job
ctl.area.co.06.351.6%.job
ctl.area.co.06.351.fireplace.6%.job
ctl.avi.co.06.350.bas.job
ctl.avi.co.06.351.bas.job
ctl.mvoff.co.06.350.6%.job
ctl.mvoff.co.06.350.FEDNR6.cmp.job
ctl.mvoff.co.06.350.OXY.6%bas.job
ctl.mvoff.co.06.350.OXY.FEDNRi.6%.job
ctl.mvoff.co.06.350.OXY.cmp.6%.job
ctl.mvoff.co.06.350.OXYi.6%.cmp.job
ctl.mvoff.co.06.350.bas.job
ctl.mvoff.co.06.351.6%.job
ctl.mvoff.co.06.351.FEDNR6.cmp.job
ctl.mvoff.co.06.351.OXY.6%bas.job
ctl.mvoff.co.06.351.OXY.FEDNRi.6%.job
ctl.mvoff.co.06.351.OXY.cmp.6%.job
ctl.mvoff.co.06.351.OXYi.6%.cmp.job
ctl.mvoff.co.06.351.bas.job
grd.area.co.06.350.6%.base.job
grd.area.co.06.350.fireplace.6%.job
grd.area.co.06.351.6%.base.job
grd.area.co.06.351.fireplace.6%.job
grd.avi.co.06.350.bas.job
grd.avi.co.06.351.bas.job
grd.mvoff.co.06.350.FEDNRi.6%.job
grd.mvoff.co.06.350.OXYi.6%.job
grd.mvoff.co.06.350.bas6.job
grd.mvoff.co.06.350.cmp6.job
grd.mvoff.co.06.351.FEDNRi.6%.job
grd.mvoff.co.06.351.OXYi.6%.job
grd.pnt.co_20.06.350.6%.job
grd.pnt.co_20.06.351.6%.job
mrg.co.06.350.cmp.R11.job
mrg.co.06.351.cmp.R11.job
prp.co_20.06.350.6%.job
prp.co_20.06.351.6%.job
pst.pnt.co_20.06.350.6%.job
pst.pnt.co_20.06.351.6%.job
tpl.area.co.06.350.6%.base.job
tpl.area.co.06.350.fireplace.6%.job
tpl.area.co.06.351.6%.base.job
tpl.area.co.06.351.fireplace.6%.job
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```
tpl.avi.co.06.350.bas.job
tpl.avi.co.06.351.bas.job
tpl.mvoff.co.06.350.FEDNRi.6%.job
tpl.mvoff.co.06.350.OXYi.6%.job
tpl.mvoff.co.06.350.bas6.job
tpl.mvoff.co.06.350.cmp6.job
tpl.mvoff.co.06.351.FEDNRi.6%.job
tpl.mvoff.co.06.351.OXYi.6%.job
tpl.mvoff.co.06.351.bas6.job
tpl.mvoff.co.06.351.cmp6.job
tpl.pnt.co_20.06.350.6%.job
tpl.pnt.co_20.06.351.6%.job

./eps2/job/2015:
chm.area.co.15.350.fireplace.15%.job
chm.area.co.15.351.fireplace.15%.job
chm.avi.co.15.350.base.R2.job
chm.avi.co.15.351.base.R2.job
chm.mvoff.co.15.350.cmp.final.job
chm.mvoff.co.15.351.cmp.final.job
chm.pnt.co_20.15.350.15%.job
chm.pnt.co_20.15.351.15%.job
ctl.area.co.15.350.15%.job
ctl.area.co.15.350.bas2.job
ctl.area.co.15.350.fireplace.15%.job
ctl.area.co.15.351.15%.job
ctl.area.co.15.351.bas2.job
ctl.area.co.15.351.fireplace.15%.job
ctl.avi.co.15.350.basR2.job
ctl.avi.co.15.351.basR2.job
ctl.mvoff.co.15.350.FEDNR15.final.job
ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.350.OXYFUELS.ind.job
ctl.mvoff.co.15.350.bas2.job
ctl.mvoff.co.15.350.final+15%.job
ctl.mvoff.co.15.351.FEDNR15.final.job
ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.351.OXYFUELS.ind.job
ctl.mvoff.co.15.351.bas2.job
ctl.mvoff.co.15.351.final+15%.job
grd.area.co.15.350.fireplace.15%.CARB.job
grd.area.co.15.351.fireplace.15%.CARB.job
grd.avi.co.15.350.bas.R2CB.job
grd.avi.co.15.351.bas.R2CB.job
grd.mvoff.co.15.350.cm.final.job
grd.mvoff.co.15.351.cm.final.job
grd.pnt.co_20.15.350.15%R2.job
grd.pnt.co_20.15.351.15%R2.job
lbs.co.99.350.bas.job
lbs.co.99.351.bas.job
mrg.co.15.350.cmp.rev12
mrg.co.15.351.cmp.rev12
pra.co.15.350.job.final
pra.co.15.351.job.final
prp.co_20.15.350.15%.job
prp.co_20.15.351.15%.job
pst.pnt.co_20.15.350.15%R2.job
pst.pnt.co_20.15.351.15%R2.job
tpl.area.co.15.350.fireplace.15%.job.CARB
tpl.area.co.15.351.fireplace.15%.job.CARB
tpl.avi.co.15.350.bas.R2CB.job
tpl.avi.co.15.351.bas.R2CB.job
tpl.mvoff.co.15.350.cm.final.job
tpl.mvoff.co.15.351.cm.final.job
tpl.pnt.co_20.15.350.15%R2.job
tpl.pnt.co_20.15.351.15%R2.job

./eps2/job/2015_ind_measures:
chm.area.co.15.350.fireplace.15%.job
chm.area.co.15.351.fireplace.15%.job
chm.mvoff.co.15.350.FEDNR.ind.job
chm.mvoff.co.15.350.OXY.ind.job
chm.mvoff.co.15.351.FEDNR.ind.job
chm.mvoff.co.15.351.OXY.ind.job
ctl.area.co.15.350.15%.job
ctl.area.co.15.350.bas2.job
ctl.area.co.15.350.fireplace.15%.job
ctl.area.co.15.351.15%.job
ctl.area.co.15.351.bas2.job
ctl.area.co.15.351.fireplace.15%.job
ctl.mvoff.co.15.350.FEDNR.ind.job
ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.350.OXYFUELS.ind.job
ctl.mvoff.co.15.350.bas2.job
ctl.mvoff.co.15.350.final+15%.job
ctl.mvoff.co.15.351.FEDNR.ind.job
ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.351.OXYFUELS.ind.job
ctl.mvoff.co.15.351.bas2.job
ctl.mvoff.co.15.351.final+15%.job
grd.area.co.15.350.fireplace.15%.CARB.job
grd.area.co.15.351.fireplace.15%.CARB.job
grd.mvoff.co.15.350.FEDNR.ind.job
grd.mvoff.co.15.350.OXY.ind.job
grd.mvoff.co.15.351.FEDNR.ind.job
grd.mvoff.co.15.351.OXY.ind.job
pra.co.15.350.job.final
pra.co.15.351.job.final
tpl.area.co.15.350.fireplace.15%.job.CARB
tpl.area.co.15.351.fireplace.15%.job.CARB
tpl.mvoff.co.15.350.FEDNR.ind.job
tpl.mvoff.co.15.350.OXY.ind.job
tpl.mvoff.co.15.351.FEDNR.ind.job
tpl.mvoff.co.15.351.OXY.ind.job

./eps2/job/2015_no_measures:
chm.area.co.15.350.15%.base.job
chm.area.co.15.351.15%.base.job
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```
chm.avi.co.15.350.base.R2.job
chm.avi.co.15.351.base.R2.job
chm.mvoff.co.15.350.WOcm.final.job
chm.mvoff.co.15.351.WOcm.final.job
chm.pnt.co_20.15.350.15%.job
chm.pnt.co_20.15.351.15%.job
ctl.area.co.15.350.15%.job
ctl.area.co.15.350.bas2.job
ctl.area.co.15.351.15%.job
ctl.area.co.15.351.bas2.job
ctl.avi.co.15.350.basR2.job
ctl.avi.co.15.351.basR2.job
ctl.mvoff.co.15.350.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.350.bas2.job
ctl.mvoff.co.15.350.final+15%.job
ctl.mvoff.co.15.351.OXY15%.finalWOcmp.job
ctl.mvoff.co.15.351.bas2.job
ctl.mvoff.co.15.351.final+15%.job
grd.area.co.15.350.15%.base.job
grd.area.co.15.351.15%.base.job
grd.avi.co.15.350.bas.R2CB.job
grd.avi.co.15.351.bas.R2CB.job
grd.mvoff.co.15.350.WOcm.final.job
grd.mvoff.co.15.351.WOcm.final.job
grd.pnt.co_20.15.350.15%R2.job
grd.pnt.co_20.15.351.15%R2.job
lbs.co.99.350.bas.job
lbs.co.99.351.bas.job
pra.co.15.350.job.final
pra.co.15.351.job.final
prp.co_20.15.350.15%.job
prp.co_20.15.351.15%.job
pst.pnt.co_20.15.350.15%R2.job
pst.pnt.co_20.15.351.15%R2.job
tpl.area.co.15.350.15%.base.job
tpl.area.co.15.351.15%.base.job
tpl.avi.co.15.350.bas.R2CB.job
tpl.avi.co.15.351.bas.R2CB.job
tpl.mvoff.co.15.350.WOcm.final.job
tpl.mvoff.co.15.351.WOcm.final.job
tpl.pnt.co_20.15.350.15%R2.job
tpl.pnt.co_20.15.351.15%R2.job

./eps2/msg:
1994
2006
2015
2015_ind_measures
2015_no_measures

./eps2/msg/1994:
chm.area.co.94.350.nnrd3.err
chm.area.co.94.350.nnrd3.msg
chm.area.co.94.351.nnrd3.err
chm.area.co.94.351.nnrd3.msg
chm.avi.co.94.350.98chg.err.avicor
chm.avi.co.94.350.98chg.msg.avicor
chm.avi.co.94.351.98chg.err.avicor
chm.avi.co.94.351.98chg.msg.avicor
chm.mvoff.co.94.350.nnrd3.err
chm.mvoff.co.94.350.nnrd3.msg
chm.mvoff.co.94.351.nnrd3.err
chm.mvoff.co.94.351.nnrd3.msg
chm.pnt.co.94.350.tj20.98chg.err
chm.pnt.co.94.350.tj20.98chg.msg
chm.pnt.co.94.351.tj20.98chg.err
chm.pnt.co.94.351.tj20.98chg.msg
ctl.area.co.94.350.nnrd3.err
ctl.area.co.94.350.nnrd3.msg
ctl.area.co.94.351.nnrd3.err
ctl.area.co.94.351.nnrd3.msg
ctl.avi.co.94.350.98chg.err.avicor
ctl.avi.co.94.350.98chg.msg.avicor
ctl.avi.co.94.351.98chg.err.avicor
ctl.avi.co.94.351.98chg.msg.avicor
ctl.mvoff.co.94.350.nnrd3.adj.err
ctl.mvoff.co.94.350.nnrd3.adj.msg
ctl.mvoff.co.94.350.nnrd3.err
ctl.mvoff.co.94.350.nnrd3.msg
ctl.mvoff.co.94.350.nnrd3.ratio.err
ctl.mvoff.co.94.350.nnrd3.ratio.msg
ctl.mvoff.co.94.350.nnrd3.reduce.err
ctl.mvoff.co.94.350.nnrd3.reduce.msg
ctl.mvoff.co.94.351.nnrd3.adj.err
ctl.mvoff.co.94.351.nnrd3.adj.msg
ctl.mvoff.co.94.351.nnrd3.err
ctl.mvoff.co.94.351.nnrd3.msg
ctl.mvoff.co.94.351.nnrd3.ratio.err
ctl.mvoff.co.94.351.nnrd3.ratio.msg
ctl.mvoff.co.94.351.nnrd3.reduce.err
ctl.mvoff.co.94.351.nnrd3.reduce.msg
grd.area.co.94.350.nnrd3.err.wood
grd.area.co.94.350.nnrd3.msg.wood
grd.area.co.94.351.nnrd3.err.wood
grd.area.co.94.351.nnrd3.msg.wood
grd.avi.co.94.350.98chg.err.avicor
grd.avi.co.94.350.98chg.msg.avicor
grd.avi.co.94.351.98chg.err.avicor
grd.avi.co.94.351.98chg.msg.avicor
grd.mvoff.co.94.350.nnrd3.err
grd.mvoff.co.94.350.nnrd3.msg
grd.mvoff.co.94.351.nnrd3.err
grd.mvoff.co.94.351.nnrd3.msg
grd.pnt.co.94.350.tj20.98chg.err
grd.pnt.co.94.350.tj20.98chg.msg
grd.pnt.co.94.351.tj20.98chg.err
grd.pnt.co.94.351.tj20.98chg.msg
lbs.avi.co.94.350.98chg.err
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lbs.avi.co.94.350.98chg.msg
lbs.avi.co.94.351.98chg.err
lbs.avi.co.94.351.98chg.msg
mrg.co.94.350.msg.sd2.M6Link
mrg.co.94.351.msg.sd2.M6Link
pra.area.co.94.350.nnrd3.err
pra.area.co.94.350.nnrd3.msg
pra.area.co.94.351.nnrd3.err
pra.area.co.94.351.nnrd3.msg
prp.pnt.co.94.350.tj20.98chg.err
prp.pnt.co.94.350.tj20.98chg.msg
prp.pnt.co.94.351.tj20.98chg.err
prp.pnt.co.94.351.tj20.98chg.msg
pst.pnt.co.94.350.tj20.98chg.err
pst.pnt.co.94.350.tj20.98chg.msg
pst.pnt.co.94.351.tj20.98chg.err
pst.pnt.co.94.351.tj20.98chg.msg
tpl.area.co.94.350.nnrd3.err.wood
tpl.area.co.94.350.nnrd3.msg.wood
tpl.area.co.94.351.nnrd3.err.wood
tpl.area.co.94.351.nnrd3.msg.wood
tpl.avi.co.94.350.98chg.err.avicor
tpl.avi.co.94.350.98chg.msg.avicor
tpl.avi.co.94.351.98chg.err.avicor
tpl.avi.co.94.351.98chg.msg.avicor
tpl.mvoff.co.94.350.nnrd3.err
tpl.mvoff.co.94.350.nnrd3.msg
tpl.mvoff.co.94.351.nnrd3.err
tpl.mvoff.co.94.351.nnrd3.msg
tpl.pnt.co.94.350.tj20.98chg.err
tpl.pnt.co.94.350.tj20.98chg.msg
tpl.pnt.co.94.351.tj20.98chg.err
tpl.pnt.co.94.351.tj20.98chg.msg

./eps2/msg/2006:
chm.area.co.06.350.base6.msg
chm.area.co.06.350.fire6.msg
chm.area.co.06.351.base6.msg
chm.area.co.06.351.fire6.msg
chm.avi.co.06.350.bas.msg
chm.avi.co.06.351.bas.msg
chm.mvoff.co.06.350.NRi6.msg
chm.mvoff.co.06.350.OXYi6.msg
chm.mvoff.co.06.350.bas6.msg
chm.mvoff.co.06.350.cmp6.msg
chm.mvoff.co.06.351.NRi6.msg
chm.mvoff.co.06.351.OXYi6.msg
chm.mvoff.co.06.351.bas6.msg
chm.mvoff.co.06.351.cmp6.msg
chm.pnt.co_20.06.350.6%.msg
chm.pnt.co_20.06.351.6%.msg
ctl.area.co.06.350.6%.msg
ctl.area.co.06.350.bas.msg
ctl.area.co.06.350.fire6.msg
ctl.area.co.06.351.6%.msg
ctl.area.co.06.351.bas.msg
ctl.area.co.06.351.fire6.msg
ctl.avi.co.06.350.bas.msg
ctl.avi.co.06.351.bas.msg
ctl.mvof.co.06.350.FEDNRi.msg
ctl.mvof.co.06.350.NRi6.msg
ctl.mvof.co.06.350.OXYi6.msg
ctl.mvof.co.06.350.bas6fl.msg
ctl.mvof.co.06.350.cmpOX6.msg
ctl.mvof.co.06.351.FEDNRi.msg
ctl.mvof.co.06.351.NRi6.msg
ctl.mvof.co.06.351.OXYi-10.msg
ctl.mvof.co.06.351.OXYi6.msg
ctl.mvof.co.06.351.bas6fl.msg
ctl.mvof.co.06.351.cmpOX6.msg
ctl.mvoff.co.06.350.6%.msg
ctl.mvoff.co.06.350.cmNR6.msg
ctl.mvoff.co.06.351.6%.msg
ctl.mvoff.co.06.351.cmNR6.msg
grd.area.co.06.350.bas6.msg
grd.area.co.06.350.cmp6%.msg
grd.area.co.06.351.bas6.msg
grd.area.co.06.351.cmp6%.msg
grd.avi.co.06.350.bas.msg
grd.avi.co.06.351.bas.msg
grd.mvoff.co.06.350.NRi6.msg
grd.mvoff.co.06.350.OXYi6.msg
grd.mvoff.co.06.350.bas6.msg
grd.mvoff.co.06.350.cmp6.msg
grd.mvoff.co.06.351.NRi6.msg
grd.mvoff.co.06.351.OXYi6.msg
grd.mvoff.co.06.351.bas6.msg
grd.mvoff.co.06.351.cmp6.msg
grd.pnt.co_20.06.350.6%.msg
grd.pnt.co_20.06.351.6%.msg
prp.co_20.06.350.6%.msg
prp.co_20.06.350.6%.stkrpt
prp.co_20.06.351.6%.msg
prp.co_20.06.351.6%.stkrpt
pst.pt.co_20.06.350.6%.msg
pst.pt.co_20.06.351.6%.msg
tpl.area.co.06.350.bas6.msg
tpl.area.co.06.350.cmp6%.msg
tpl.area.co.06.351.bas6.msg
tpl.area.co.06.351.cmp6%.msg
tpl.avi.co.06.350.bas.msg
tpl.avi.co.06.351.bas.msg
tpl.mvoff.co.06.350.NRi6.msg
tpl.mvoff.co.06.350.OXYi6.msg
tpl.mvoff.co.06.350.bas6.msg
tpl.mvoff.co.06.350.cmp6.msg
tpl.mvoff.co.06.351.NRi6.msg
tpl.mvoff.co.06.351.OXYi6.msg
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tpl.mvoff.co.06.351.bas6.msg
tpl.mvoff.co.06.351.cmp6.msg
tpl.pnt.co_20.06.350.6%.msg
tpl.pnt.co_20.06.351.6%.msg

./eps2/msg/2015:
chm.area.co.15.350.fire15.err
chm.area.co.15.350.fire15.msg
chm.area.co.15.351.fire15.err
chm.area.co.15.351.fire15.msg
chm.avi.co.15.350.basR2.err
chm.avi.co.15.350.basR2.msg
chm.avi.co.15.351.basR2.err
chm.avi.co.15.351.basR2.msg
chm.mvoff.co.15.350.cmFI.err
chm.mvoff.co.15.350.cmFI.msg
chm.mvoff.co.15.351.cmFI.err
chm.mvoff.co.15.351.cmFI.msg
chm.pnt.co_20.15.350.15%.err
chm.pnt.co_20.15.350.15%.msg
chm.pnt.co_20.15.351.15%.err
chm.pnt.co_20.15.351.15%.msg
ctl.area.co.15.350.15%.err
ctl.area.co.15.350.15%.msg
ctl.area.co.15.350.FIN.err
ctl.area.co.15.350.FIN.msg
ctl.area.co.15.350.fire15.err
ctl.area.co.15.350.fire15.msg
ctl.area.co.15.351.15%.err
ctl.area.co.15.351.15%.msg
ctl.area.co.15.351.FIN.err
ctl.area.co.15.351.FIN.msg
ctl.area.co.15.351.fire15.err
ctl.area.co.15.351.fire15.msg
ctl.avi.co.15.350.basR2.err
ctl.avi.co.15.350.basR2.msg
ctl.avi.co.15.351.basR2.err
ctl.avi.co.15.351.basR2.msg
ctl.mvoff.co.15.350.FEFCM.err
ctl.mvoff.co.15.350.FEFCM.msg
ctl.mvoff.co.15.350.OXYWO.err
ctl.mvoff.co.15.350.OXYWO.msg
ctl.mvoff.co.15.350.OXYi.err
ctl.mvoff.co.15.350.OXYi.msg
ctl.mvoff.co.15.350.bas2.err
ctl.mvoff.co.15.350.bas2.msg
ctl.mvoff.co.15.350.fin15%.err
ctl.mvoff.co.15.350.fin15%.msg
ctl.mvoff.co.15.351.FEFCM.err
ctl.mvoff.co.15.351.FEFCM.msg
ctl.mvoff.co.15.351.OXYWO.err
ctl.mvoff.co.15.351.OXYWO.msg
ctl.mvoff.co.15.351.OXYi.err
ctl.mvoff.co.15.351.OXYi.msg
ctl.mvoff.co.15.351.bas2.err
ctl.mvoff.co.15.351.bas2.msg
ctl.mvoff.co.15.351.fin15%.err
ctl.mvoff.co.15.351.fin15%.msg
grd.area.co.15.350.cmp15.err
grd.area.co.15.350.cmp15.msg
grd.area.co.15.351.cmp15.err
grd.area.co.15.351.cmp15.msg
grd.avi.co.15.350.basR2CB.err
grd.avi.co.15.350.basR2CB.msg
grd.avi.co.15.351.basR2CB.err
grd.avi.co.15.351.basR2CB.msg
grd.mvoff.co.15.350.cmFI.err
grd.mvoff.co.15.350.cmFI.msg
grd.mvoff.co.15.351.cmFI.err
grd.mvoff.co.15.351.cmFI.msg
grd.pnt.co_20.15.350.15%R2.err
grd.pnt.co_20.15.350.15%R2.msg
grd.pnt.co_20.15.351.15%R2.err
grd.pnt.co_20.15.351.15%R2.msg
lb.av.99.350.err
lb.av.99.350.msg
lb.av.99.351.err
lb.av.99.351.msg
mrg.co.15.350.cmp.R12.msg
mrg.co.15.351.cmp.R12.msg
pra.area.co.99.350.final.err
pra.area.co.99.350.final.msg
pra.area.co.99.351.final.err
pra.area.co.99.351.final.msg
prp.co_20.15.350.15%.err
prp.co_20.15.350.15%.msg
prp.co_20.15.350.15%.stkrpt
prp.co_20.15.351.15%.err
prp.co_20.15.351.15%.msg
prp.co_20.15.351.15%.stkrpt
pst.pt.co_20.15.350.15%R2.msg
pst.pt.co_20.15.351.15%R2.err
pst.pt.co_20.15.351.15%R2.msg
pt.pnt.co_20.15.350.15%R2.err
tpl.area.co.15.350.cmp15.err
tpl.area.co.15.350.cmp15.msg
tpl.area.co.15.351.cmp15.err
tpl.area.co.15.351.cmp15.msg
tpl.avi.co.15.350.basR2CB.err
tpl.avi.co.15.350.basR2CB.msg
tpl.avi.co.15.351.basR2CB.err
tpl.avi.co.15.351.basR2CB.msg
tpl.mvoff.co.15.350.cmFI.err
tpl.mvoff.co.15.350.cmFI.msg
tpl.mvoff.co.15.351.cmFI.err
tpl.mvoff.co.15.351.cmFI.msg
tpl.pnt.co_20.15.350.15%R2.err
tpl.pnt.co_20.15.350.15%R2.msg
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tpl.pnt.co_20.15.351.15%R2.err
tpl.pnt.co_20.15.351.15%R2.msg

./eps2/msg/2015_ind_measures:
chm.area.co.15.350.fire15.err
chm.area.co.15.350.fire15.msg
chm.area.co.15.351.fire15.err
chm.area.co.15.351.fire15.msg
chm.mvoff.co.15.350.FEDNRi.err
chm.mvoff.co.15.350.FEDNRi.msg
chm.mvoff.co.15.350.OXYi.err
chm.mvoff.co.15.350.OXYi.msg
chm.mvoff.co.15.351.FEDNRi.err
chm.mvoff.co.15.351.FEDNRi.msg
chm.mvoff.co.15.351.OXYi.err
chm.mvoff.co.15.351.OXYi.msg
ctl.area.co.15.350.15%.err
ctl.area.co.15.350.15%.msg
ctl.area.co.15.350.FIN.err
ctl.area.co.15.350.FIN.msg
ctl.area.co.15.350.fire15.err
ctl.area.co.15.350.fire15.msg
ctl.area.co.15.351.15%.err
ctl.area.co.15.351.15%.msg
ctl.area.co.15.351.FIN.err
ctl.area.co.15.351.FIN.msg
ctl.area.co.15.351.fire15.err
ctl.area.co.15.351.fire15.msg
ctl.mvoff.co.15.350.FEDNRi.err
ctl.mvoff.co.15.350.FEDNRi.msg
ctl.mvoff.co.15.350.OXYWO.err
ctl.mvoff.co.15.350.OXYWO.msg
ctl.mvoff.co.15.350.OXYi.err
ctl.mvoff.co.15.350.OXYi.msg
ctl.mvoff.co.15.350.bas2.err
ctl.mvoff.co.15.350.bas2.msg
ctl.mvoff.co.15.350.fin15%.err
ctl.mvoff.co.15.350.fin15%.msg
ctl.mvoff.co.15.351.FEDNRi.err
ctl.mvoff.co.15.351.FEDNRi.msg
ctl.mvoff.co.15.351.OXYWO.err
ctl.mvoff.co.15.351.OXYWO.msg
ctl.mvoff.co.15.351.OXYi.err
ctl.mvoff.co.15.351.OXYi.msg
ctl.mvoff.co.15.351.bas2.err
ctl.mvoff.co.15.351.bas2.msg
ctl.mvoff.co.15.351.fin15%.err
ctl.mvoff.co.15.351.fin15%.msg
grd.area.co.15.350.cmp15.err
grd.area.co.15.350.cmp15.msg
grd.area.co.15.351.cmp15.err
grd.area.co.15.351.cmp15.msg
grd.mvoff.co.15.350.FEDNRi.err
grd.mvoff.co.15.350.FEDNRi.msg
grd.mvoff.co.15.350.OXYi.err
grd.mvoff.co.15.350.OXYi.msg
grd.mvoff.co.15.351.FEDNRi.err
grd.mvoff.co.15.351.FEDNRi.msg
grd.mvoff.co.15.351.OXYi.err
grd.mvoff.co.15.351.OXYi.msg
pra.area.co.99.350.final.err
pra.area.co.99.350.final.msg
pra.area.co.99.351.final.err
pra.area.co.99.351.final.msg
tpl.area.co.15.350.cmp15.err
tpl.area.co.15.350.cmp15.msg
tpl.area.co.15.351.cmp15.err
tpl.area.co.15.351.cmp15.msg
tpl.mvoff.co.15.350.FEDNRi.err
tpl.mvoff.co.15.350.FEDNRi.msg
tpl.mvoff.co.15.350.OXYi.err
tpl.mvoff.co.15.350.OXYi.msg
tpl.mvoff.co.15.351.FEDNRi.err
tpl.mvoff.co.15.351.FEDNRi.msg
tpl.mvoff.co.15.351.OXYi.err
tpl.mvoff.co.15.351.OXYi.msg

./eps2/msg/2015_no_measures:
chm.area.co.15.350.base15.err
chm.area.co.15.350.base15.msg
chm.area.co.15.351.base15.err
chm.area.co.15.351.base15.msg
chm.avi.co.15.350.basR2.err
chm.avi.co.15.350.basR2.msg
chm.avi.co.15.351.basR2.err
chm.avi.co.15.351.basR2.msg
chm.mvoff.co.15.350.WOcm.err
chm.mvoff.co.15.350.WOcm.msg
chm.mvoff.co.15.351.WOcm.err
chm.mvoff.co.15.351.WOcm.msg
chm.pnt.co_20.15.350.15%.err
chm.pnt.co_20.15.350.15%.msg
chm.pnt.co_20.15.351.15%.err
chm.pnt.co_20.15.351.15%.msg
ctl.area.co.15.350.15%.err
ctl.area.co.15.350.15%.msg
ctl.area.co.15.350.FIN.err
ctl.area.co.15.350.FIN.msg
ctl.area.co.15.351.15%.err
ctl.area.co.15.351.15%.msg
ctl.area.co.15.351.FIN.err
ctl.area.co.15.351.FIN.msg
ctl.avi.co.15.350.basR2.err
ctl.avi.co.15.350.basR2.msg
ctl.avi.co.15.351.basR2.err
ctl.avi.co.15.351.basR2.msg
ctl.mvoff.co.15.350.OXYWO.err
ctl.mvoff.co.15.350.OXYWO.msg
```

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ctl.mvoff.co.15.350.bas2.err
ctl.mvoff.co.15.350.bas2.msg
ctl.mvoff.co.15.350.fin15%.err
ctl.mvoff.co.15.350.fin15%.msg
ctl.mvoff.co.15.351.OXYWO.err
ctl.mvoff.co.15.351.OXYWO.msg
ctl.mvoff.co.15.351.bas2.err
ctl.mvoff.co.15.351.bas2.msg
ctl.mvoff.co.15.351.fin15%.err
ctl.mvoff.co.15.351.fin15%.msg
grd.area.co.15.350.bas15.err
grd.area.co.15.350.bas15.msg
grd.area.co.15.351.bas15.err
grd.area.co.15.351.bas15.msg
grd.avi.co.15.350.basR2CB.err
grd.avi.co.15.350.basR2CB.msg
grd.avi.co.15.351.basR2CB.err
grd.avi.co.15.351.basR2CB.msg
grd.mvoff.co.15.350.WOcm.err
grd.mvoff.co.15.350.WOcm.msg
grd.mvoff.co.15.351.WOcm.err
grd.mvoff.co.15.351.WOcm.msg
grd.pnt.co_20.15.350.15%R2.err
grd.pnt.co_20.15.350.15%R2.msg
grd.pnt.co_20.15.351.15%R2.err
grd.pnt.co_20.15.351.15%R2.msg
lb.av.99.350.err
lb.av.99.350.msg
lb.av.99.351.err
lb.av.99.351.msg
pra.area.co.99.350.final.err
pra.area.co.99.350.final.msg
pra.area.co.99.351.final.err
pra.area.co.99.351.final.msg
prp.co_20.15.350.15%.err
prp.co_20.15.350.15%.msg
prp.co_20.15.350.15%.stkrpt
prp.co_20.15.351.15%.err
prp.co_20.15.351.15%.msg
prp.co_20.15.351.15%.stkrpt
pst.pt.co_20.15.350.15%R2.msg
pst.pt.co_20.15.351.15%R2.err
pst.pt.co_20.15.351.15%R2.msg
pt.pnt.co_20.15.350.15%R2.err
tpl.area.co.15.350.bas15.err
tpl.area.co.15.350.bas15.msg
tpl.area.co.15.351.bas15.err
tpl.area.co.15.351.bas15.msg
tpl.avi.co.15.350.basR2CB.err
tpl.avi.co.15.350.basR2CB.msg
tpl.avi.co.15.351.basR2CB.err
tpl.avi.co.15.351.basR2CB.msg
tpl.mvoff.co.15.350.WOcm.err
tpl.mvoff.co.15.350.WOcm.msg
tpl.mvoff.co.15.351.WOcm.err
tpl.mvoff.co.15.351.WOcm.msg
tpl.pnt.co_20.15.350.15%R2.err
tpl.pnt.co_20.15.350.15%R2.msg
tpl.pnt.co_20.15.351.15%R2.err
tpl.pnt.co_20.15.351.15%R2.msg

./eps2/out:
1994
2006
2015
2015_ind_measures
2015_no_measures

./eps2/out/1994:
chm.area.co.94.350.nnrd3.embr
chm.area.co.94.351.nnrd3.embr
chm.avi.co.94.350.98chg.embr.avicor
chm.avi.co.94.351.98chg.embr.avicor
chm.mvoff.co.94.350.nnrd3.embr
chm.mvoff.co.94.351.nnrd3.embr
chm.pnt.co.94.350.tj20.98chg.embr
chm.pnt.co.94.351.tj20.98chg.embr
ctl.area.co.94.350.nnrd3.embr
ctl.area.co.94.351.nnrd3.embr
ctl.avi.co.94.350.98chg.embr.avicor
ctl.avi.co.94.351.98chg.embr.avicor
ctl.mvoff.co.94.350.nnrd3.adj.embr
ctl.mvoff.co.94.350.nnrd3.embr
ctl.mvoff.co.94.350.nnrd3.ratio.embr
ctl.mvoff.co.94.350.nnrd3.reduce.embr
ctl.mvoff.co.94.351.nnrd3.adj.embr
ctl.mvoff.co.94.351.nnrd3.embr
ctl.mvoff.co.94.351.nnrd3.ratio.embr
ctl.mvoff.co.94.351.nnrd3.reduce.embr
grd.area.co.94.350.nnrd3.emiss.wood
grd.area.co.94.351.nnrd3.emiss.wood
grd.avi.co.94.350.98chg.emiss.avicor
grd.avi.co.94.351.98chg.emiss.avicor
grd.mvoff.co.94.350.nnrd3.emiss
grd.mvoff.co.94.351.nnrd3.emiss
grd.pnt.co.94.350.tj20.98chg.emiss
grd.pnt.co.94.351.tj20.98chg.emiss
lbs.avi.co.94.350.98chg.embr
lbs.avi.co.94.351.98chg.embr
mrg.co.94.350.M6Link.sd2
mrg.co.94.351.M6Link.sd2
pra.area.co.94.350.nnrd3.embr
pra.area.co.94.351.nnrd3.embr
pra.mvoff.co.94.350.nnrd3.embr
pra.mvoff.co.94.351.nnrd3.embr
prp.pnt.co.94.350.tj20.98chg.embr
prp.pnt.co.94.350.tj20.98chg.stkrpt
prp.pnt.co.94.351.tj20.98chg.embr
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prp.pnt.co.94.351.tj20.98chg.stkrpt
pst.pnt.co.94.350.tj20.98chg.embr
pst.pnt.co.94.351.tj20.98chg.embr
tpl.area.co.94.350.nnrd3.embr.wood
tpl.area.co.94.351.nnrd3.embr.wood
tpl.avi.co.94.350.98chg.embr.avicor
tpl.avi.co.94.351.98chg.embr.avicor
tpl.mvoff.co.94.350.nnrd3.embr
tpl.mvoff.co.94.351.nnrd3.embr
tpl.pnt.co.94.350.tj20.98chg.embr
tpl.pnt.co.94.351.tj20.98chg.embr

./eps2/out/2006:
chm.area.co.06.350.base6.embr
chm.area.co.06.350.fire6.embr
chm.area.co.06.351.base6.embr
chm.area.co.06.351.fire6.embr
chm.avi.co.06.350.bas.embr
chm.avi.co.06.351.bas.embr
chm.mvoff.co.06.350.NRi6.embr
chm.mvoff.co.06.350.OXYi6.embr
chm.mvoff.co.06.350.bas6.embr
chm.mvoff.co.06.350.cmp6.embr
chm.mvoff.co.06.351.NRi6.embr
chm.mvoff.co.06.351.OXYi6.embr
chm.mvoff.co.06.351.bas6.embr
chm.mvoff.co.06.351.cmp6.embr
chm.pnt.co_20.06.350.6%.embr
chm.pnt.co_20.06.351.6%.embr
ctl.area.co.06.350.6%.embr
ctl.area.co.06.350.bas.embr
ctl.area.co.06.350.fire6.embr
ctl.area.co.06.351.6%.embr
ctl.area.co.06.351.bas.embr
ctl.area.co.06.351.fire6.embr
ctl.avi.co.06.350.bas.embr
ctl.avi.co.06.351.bas.embr
ctl.mvof.co.06.350.NRi6.embr
ctl.mvof.co.06.350.OXYi6.embr
ctl.mvof.co.06.350.bas6fl.embr
ctl.mvof.co.06.350.cmpOX6.embr
ctl.mvof.co.06.351.NRi6.embr
ctl.mvof.co.06.351.OXYi6.embr
ctl.mvof.co.06.351.bas6fl.embr
ctl.mvof.co.06.351.cmpOX6.embr
ctl.mvoff.co.06.350.6%.embr
ctl.mvoff.co.06.350.cmNR6.embr
ctl.mvoff.co.06.351.6%.embr
ctl.mvoff.co.06.351.cmNR6.embr
grd.area.co.06.350.bas6.emiss
grd.area.co.06.350.cmp6%.emiss
grd.area.co.06.351.bas6.emiss
grd.area.co.06.351.cmp6%.emiss
grd.avi.co.06.350.bas.emiss
grd.avi.co.06.351.bas.emiss
grd.mvoff.co.06.350.NRi6.emis
grd.mvoff.co.06.350.OXYi6.emis
grd.mvoff.co.06.350.bas6.emis
grd.mvoff.co.06.350.cmp6.emiss
grd.mvoff.co.06.351.NRi6.emis
grd.mvoff.co.06.351.OXYi6.emis
grd.mvoff.co.06.351.bas6.emis
grd.mvoff.co.06.351.cmp6.emiss
grd.pnt.co_20.06.350.6%.emiss
grd.pnt.co_20.06.351.6%.emiss
prp.co_20.06.350.6%.embr
prp.co_20.06.351.6%.embr
pst.pt.co_20.06.350.6%.embr~
pst.pt.co_20.06.351.6%.embr~
tpl.area.co.06.350.bas6.embr
tpl.area.co.06.350.cmp6%.embr
tpl.area.co.06.351.bas6.embr
tpl.area.co.06.351.cmp6%.embr
tpl.avi.co.06.350.bas.embr
tpl.avi.co.06.351.bas.embr
tpl.mvoff.co.06.350.NRi6.emb
tpl.mvoff.co.06.350.OXYi6.embr
tpl.mvoff.co.06.350.bas6.embr
tpl.mvoff.co.06.350.cmp6.embr
tpl.mvoff.co.06.351.NRi6.emb
tpl.mvoff.co.06.351.OXYi6.embr
tpl.mvoff.co.06.351.bas6.embr
tpl.mvoff.co.06.351.cmp6.embr
tpl.pnt.co_20.06.350.6%.embr
tpl.pnt.co_20.06.351.6%.embr

./eps2/out/2015:
chm.area.co.15.350.fire15.embr
chm.area.co.15.351.fire15.embr
chm.avi.co.15.350.basR2.embr
chm.avi.co.15.351.basR2.embr
chm.mvoff.co.15.350.cmFI.embr
chm.mvoff.co.15.351.cmFI.embr
chm.pnt.co_20.15.350.15%.embr
chm.pnt.co_20.15.351.15%.embr
ctl.area.co.15.350.15%.embr
ctl.area.co.15.350.FIN.embr
ctl.area.co.15.350.fire15.embr
ctl.area.co.15.351.15%.embr
ctl.area.co.15.351.FIN.embr
ctl.area.co.15.351.fire15.embr
ctl.avi.co.15.350.basR2.embr
ctl.avi.co.15.351.basR2.embr
ctl.mvoff.co.15.350.FEFCM.embr
ctl.mvoff.co.15.350.OXYWO.embr
ctl.mvoff.co.15.350.OXYi.embr
ctl.mvoff.co.15.350.bas2.embr
ctl.mvoff.co.15.350.fin15%.emb
```

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ctl.mvoff.co.15.351.FEFCM.embr
ctl.mvoff.co.15.351.OXYWO.embr
ctl.mvoff.co.15.351.OXYi.embr
ctl.mvoff.co.15.351.bas2.embr
ctl.mvoff.co.15.351.fin15%.emb
grd.area.co.15.350.cmp15.emiss
grd.area.co.15.351.cmp15.emiss
grd.avi.co.15.350.basR2CB.emis
grd.avi.co.15.351.basR2CB.emis
grd.mvoff.co.15.350.cmFI.emiss
grd.mvoff.co.15.351.cmFI.emiss
grd.pnt.co_20.15.350.15%R2.emi
grd.pnt.co_20.15.351.15%R2.emi
lb.av.99.350.embr
lb.av.99.351.embr
mrg.co.15.350.cmp.R12.emiss
mrg.co.15.351.cmp.R12.emiss
pra.area.co.99.350.final.embr
pra.area.co.99.351.final.embr
pra.mvoff.co.99.350.final.embr
pra.mvoff.co.99.351.final.embr
prp.co_20.15.350.15%.embr
prp.co_20.15.351.15%.embr
pst.pt.co_20.15.350.15%R2.embr
pst.pt.co_20.15.351.15%R2.embr
tpl.area.co.15.350.cmp15.embr
tpl.area.co.15.351.cmp15.embr
tpl.avi.co.15.350.basR2CB.embr
tpl.avi.co.15.351.basR2CB.embr
tpl.mvoff.co.15.350.cmFI.embr
tpl.mvoff.co.15.351.cmFI.embr
tpl.pnt.co_20.15.350.15%R2.embr
tpl.pnt.co_20.15.351.15%R2.embr

./eps2/out/2015_ind_measures:
chm.area.co.15.350.fire15.embr
chm.area.co.15.351.fire15.embr
chm.mvoff.co.15.350.FEDNi.embr
chm.mvoff.co.15.350.OXYi.embr
chm.mvoff.co.15.351.FEDNi.embr
chm.mvoff.co.15.351.OXYi.embr
ctl.area.co.15.350.15%.embr
ctl.area.co.15.350.FIN.embr
ctl.area.co.15.350.fire15.embr
ctl.area.co.15.351.15%.embr
ctl.area.co.15.351.FIN.embr
ctl.area.co.15.351.fire15.embr
ctl.mvoff.co.15.350.FEDNi.embr
ctl.mvoff.co.15.350.OXYWO.embr
ctl.mvoff.co.15.350.OXYi.embr
ctl.mvoff.co.15.350.bas2.embr
ctl.mvoff.co.15.350.fin15%.emb
ctl.mvoff.co.15.351.FEDNi.embr
ctl.mvoff.co.15.351.OXYWO.embr
ctl.mvoff.co.15.351.OXYi.embr
ctl.mvoff.co.15.351.bas2.embr
ctl.mvoff.co.15.351.fin15%.emb
grd.area.co.15.350.cmp15.emiss
grd.area.co.15.351.cmp15.emiss
grd.mvoff.co.15.350.FEDNi.emis
grd.mvoff.co.15.350.OXYi.emiss
grd.mvoff.co.15.351.FEDNi.emis
grd.mvoff.co.15.351.OXYi.emiss
pra.area.co.99.350.final.embr
pra.area.co.99.351.final.embr
tpl.area.co.15.350.cmp15.embr
tpl.area.co.15.351.cmp15.embr
tpl.mvoff.co.15.350.FEDNi.embr
tpl.mvoff.co.15.350.OXYi.embr
tpl.mvoff.co.15.351.FEDNi.embr
tpl.mvoff.co.15.351.OXYi.embr

./eps2/out/2015_no_measures:
chm.area.co.15.350.base15.embr
chm.area.co.15.351.base15.embr
chm.avi.co.15.350.basR2.embr
chm.avi.co.15.351.basR2.embr
chm.mvoff.co.15.350.WOcm.embr
chm.mvoff.co.15.351.WOcm.embr
chm.pnt.co_20.15.350.15%.embr
chm.pnt.co_20.15.351.15%.embr
ctl.area.co.15.350.15%.embr
ctl.area.co.15.350.FIN.embr
ctl.area.co.15.351.15%.embr
ctl.area.co.15.351.FIN.embr
ctl.avi.co.15.350.basR2.embr
ctl.avi.co.15.351.basR2.embr
ctl.mvoff.co.15.350.OXYWO.embr
ctl.mvoff.co.15.350.bas2.embr
ctl.mvoff.co.15.350.fin15%.emb
ctl.mvoff.co.15.351.OXYWO.embr
ctl.mvoff.co.15.351.bas2.embr
ctl.mvoff.co.15.351.fin15%.emb
grd.area.co.15.350.bas15.emiss
grd.area.co.15.351.bas15.emiss
grd.avi.co.15.350.basR2CB.emis
grd.avi.co.15.351.basR2CB.emis
grd.mvoff.co.15.350.WOcm.emiss
grd.mvoff.co.15.351.WOcm.emiss
grd.pnt.co_20.15.350.15%R2.emi
grd.pnt.co_20.15.351.15%R2.emi
lb.av.99.350.embr
lb.av.99.351.embr
pra.area.co.99.350.final.embr
pra.area.co.99.351.final.embr
pra.mvoff.co.99.350.final.embr
pra.mvoff.co.99.351.final.embr
prp.co_20.15.350.15%.embr
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```
prp.co_20.15.351.15%.embr
pst.pt.co_20.15.350.15%R2.embr
pst.pt.co_20.15.351.15%R2.embr
tpl.area.co.15.350.bas15.embr
tpl.area.co.15.351.bas15.embr
tpl.avi.co.15.350.basR2CB.embr
tpl.avi.co.15.351.basR2CB.embr
tpl.mvoff.co.15.350.WOcm.embr
tpl.mvoff.co.15.351.WOcm.embr
tpl.pnt.co_20.15.350.15%R2.embr
tpl.pnt.co_20.15.351.15%R2.embr

./other:

./uam:
inputs
monidata
outputs
prep
run

./uam/inputs:
aq9412_1200_20.bin
bc_050_20.bin
ch_co_test.bin
db_alam10up.bin
db_alam4.bin
mrg.co.06.350.cmp.R11.emiss
mrg.co.06.351.cmp.R11.emiss
mrg.co.15.350.cmp.R12.emiss
mrg.co.15.351.cmp.R12.emiss
mrg.co.94.350.M6Link.sd2
mrg.co.94.351.M6Link.sd2
ms_comt_20.bin
ptsrce.co_20.06.350.6%.bin
ptsrce.co_20.06.351.6%.bin
ptsrce.co_20.15.350.15%R2.emis
ptsrce.co_20.15.351.15%R2.emis
ptsrce.co_20.94.350.98chg.emis
ptsrce.co_20.94.351.98chg.emis
rt_210.bin
sfctmp20.1294.bin
tc_050_20.bin
tn.dum
wd_20.bin1216
wd_20.bin1217

./uam/monidata:
co9412_8hr.obs

./uam/outputs:
1994
2006
2015

./uam/outputs/1994:
avrg.bin1216
avrg.bin1217
depn.bin1216
depn.bin1217
inst.bin1216
inst.bin1217
log
mesg.asc1216
mesg.asc1217
sp.bin1216
sp.bin1217

./uam/outputs/2006:
avrg.bin1216
avrg.bin1217
depn.bin1216
depn.bin1217
inst.bin1216
inst.bin1217
log
mesg.asc1216
mesg.asc1217
sp.bin1216
sp.bin1217

./uam/outputs/2015:
avrg.bin1216
avrg.bin1217
depn.bin1216
depn.bin1217
inst.bin1216
inst.bin1217
log
mesg.asc1216
mesg.asc1217
sp.bin1216
sp.bin1217

./uam/prep:
DFBK
DWM
airq.job
aq9412_1200.in
bc9412_050.in
bndr.job
ch.co.job
metscl_comt.job
mspack_comt.dat
regntp.job
rt9412_210.in
tc9412.in
topconc.job
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./uam/prep/DFBK:
dbpack_alam10up.dat
dfbk_alam10up.job

./uam/prep/DWM:
diagno.in1216
diagno.in1217
diagno.lw
diagno.ter
dwm1294.job
pre1294.job
presfc.dat
preupr.dat
uamwnd.in1216
uamwnd.in1217
uamwnd1294.job

./uam/run:
uam06cmpR11.job
uam_15cmpR13.job
uam_94base5.job
```

APPENDIX III

1994 EMISSION INVENTORY DEVELOPMENT

App.III-i

Onroad Vehicle Emission Factor Estimation Procedure for 1994

App.III-i is followed by an attachment containing a sample of the MOBILE6 input files for 1994.

ONROAD VEHICLE EMISSION FACTOR ESTIMATION PROCEDURE FOR 1994

Emission Factor Model

Carbon monoxide (CO) vehicle exhaust emission factors were calculated using MOBILE6, a model developed by the Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors. The MOBILE6 runs were executed by the Maricopa Association of Governments (MAG). The contact person for the MOBILE6 emission estimates is Roger Roy (602-254-6300). More information about the MOBILE6 model may be found in the EPA User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, January 2002, EPA420-R-02-001, which may be found at the web site http://www.epa.gov/otaq/models/mobile6/r02001.pdf.

A series of MOBILE6 runs were performed to create a complete set of emission factors for input to the M6Link model.

Two Inspection/maintenance (I/M) scenarios were modeled:

1. With an I/M program in place.
2. No I/M program in place.

Five area types were modeled:

1. Central Business District
2. Urban Area
3. Urban Fringe
4. Suburban
5. Rural

Two days were modeled:

1. Friday
2. Saturday

Each combination of the above scenarios was processed through the MOBILE6 model for a total of 20 MOBILE6 runs (2 I/M status conditions X 5 area types X 2 days).

The results of the I/M and non-I/M runs for each of the five area types were combined to reflect the proportions of I/M and non I/M vehicles by the M6Link program. The term I/M vehicles means vehicles which are required to undergo an emission test and inspection under the Arizona Vehicle Inspection/Maintenance Program. It is important to note that the I/M program is required for all vehicles of the appropriate age *registered* in the nonattainment area. However, it is assumed that 88 percent of the vehicles *operating* within the nonattainment area will participate in the I/M program, and that 12 percent will not participate in the program during the 1994 time period. Refer to ATTACHMENT ONE for the actual input files for the 1994 run.

<u>Development of Model Inputs</u>

The inputs to MOBILE6 are grouped into three categories: Header inputs, Run inputs, and Scenario inputs. The input values used in the above described MOBILE6 runs are specified and explained below.

<u>Header Section</u>

1. **MOBILE6 INPUT FILE** identifies a MOBILE6 input file as a regular command input file rather than a batch file.

2. **DATABASE OUTPUT** instructs MOBILE6 to report output in database format.

3. **WITH FIELDNAMES** specifies that a header record of field names is to be generated for the database output file.

4. **DATABASE EMISSIONS : 2222 2222** indicates that all emissions types are reported in database output format if appropriate. The eight emission types are exhaust running emissions, exhaust start emissions, evaporative hot soak emissions, evaporative diurnal emissions, evaporative resting loss emissions, evaporative running loss emissions, evaporative crankcase emissions, and evaporative refueling emissions. For carbon monoxide, only exhaust running emissions and exhaust start emissions are relevant.

5. **DATABASE FACILITIES : Arterial Freeway Local Ramp None** instructs MOBILE6 to output emissions in the database output table specific to each of the four roadway types modeled by MOBILE6. Also, emissions that are independent of roadway type are output separately by MOBILE6.

6. **DATABASE VEHICLES : 22222 22222222 2 222 22222222 222** instructs MOBILE6 to output emission factors for all 28 vehicle classes considered by MOBILE6.

7. **POLLUTANTS : CO** instructs MOBILE6 to output emission factors for MOBILE6 only.

<u>Run Data Section</u>

The run data section includes information about the local inspection and maintenance programs, the anti-tampering program, and local vehicle registration data. For the data lines I/M PROGRAM, I/M MODEL YEARS, I/M VEHICLES, I/M STRINGENCY, I/M COMPLIANCE, and I/M WAIVER RATE the first "1" indicates that the data to follow reflects component number one of the I/M program where an I/M program may have many components. For the runs described in this report, there is one component to the I/M program in 1994 and five components to the I/M program in 2006 and 2015.

1. **I/M PROGRAM :1 1977 2050 1 T/O LOADED/IDLE** instructs MOBILE6 to model an I/M program with an I/M program start year of 1977 and 2050 end year. The program is an annual program "1". The program is a Test only rather than test and repair program "T/O". Finally, the program is a loaded/idle program.

2. **I/M MODEL YEARS : 1 1967 2020** instructs MOBILE6 that the portion of the I/M program defined in the "I/M PROGRAM" line is applied to model year 1967 through 2020 model year vehicles.

3. **I/M VEHICLES : 1 22222 22222222 2** this instructs MOBILE6 which vehicle classes are subject to this component of the I/M program where the number two indicates that a particular vehicle class is subject to the program and the number one indicates that a particular vehicle class is not subject to the program.

4. **I/M STRINGENCY : 1 28.0** defines that the expected exhaust inspection failure rate for pre-1981 model year vehicles covered by the I/M program is 28.0 percent.

5. **I/M COMPLIANCE : 1 97.0** describes the expected compliance rate within this portion of the I/M program where the compliance rate is the percentage of vehicles in the fleet that complete the I/M program and receive either a certificate of compliance or a waiver.

6. **I/M WAIVER RATES: 1 10.0 4.0** specifies the percentage of vehicles that fail an initial I/M test and do not pass a retest but receive a certificate of compliance. This input instructs MOBILE6 to set the waiver rate at 10.0 percent for pre-1981 model years and 4.0 percent for 1981 and later model years for this portion of the I/M program during the 1994 time frame.

7. **ANTI-TAMP PROG : 87 75 80 22222 22222222 2 11 097. 22221112** indicates information for the local anti-tampering program. Note that there may be more than one component of an anti-tampering program, requiring multiple inputs of this data.

   "**87**" indicates that the program began in 1987.
   "**75**" indicates that the earliest model year covered by the program is 1975.
   "**80**" indicates that the last model year covered by the program is 1980.
   "**22222**" indicates that the five light duty gasoline vehicle classes considered by MOBILE6 are all subject to this portion of the anti-tampering program.

“**22222222**" indicates that the eight heavy duty gasoline vehicle classes considered by MOBILE6 are all subject to this portion of the anti-tampering program.
“**2**" indicates that the gasoline powered buses are subject to this portion of the anti-tampering program.
“**11**" indicates that credit is to be taken for the anti-tampering program and that the test is performed annually.
“097.” indicates that the program compliance rate is 97 percent.
“**22221112**" indicates that the ATP program consists of an air pump system disablement test, catalyst removal test, fuel inlet restrictor disablement test, tailpipe lead deposit test, and gas cap test. Omitted from the program are an EGR disablement test, evaporative system disablement test, and PCV system disablement test.

9. **REG DIST: reg94.txt** indicates that local registration distribution data is provided for MOBILE6 use, rather than national default data, and that these data may be found in the external data file reg94.txt. The data input to the runs performed for this analysis reflect ADOT registration data developed in 1997.

10. **DIESEL FRACTIONS :** indicates that the user is inputting data to reflect the fraction of vehicles by vehicle class that are diesel powered, where appropriate. In the case of MAG analysis, local data is used for the vehicle classes light duty gasoline vehicles, light duty trucks 1, and light duty trucks 2. For the remaining vehicle classes, MOBILE6 default data was input. Please note that the 42 lines of registration data following the DIESEL FRACTIONS: command have not been reproduced here, but may be seen in the sample MOBILE6 input file provided with this document.

<u>**Scenario Data Section**</u>

1. **SCENARIO RECORD : I/M Scenario** is a required field that provides a unique identifier to each scenario analyzed. The individual MOBILE6 runs performed by MAG for this analysis each have only one scenario.

2. **WE VEH US :** is an input used only for the Saturday runs performed by MAG. This flag instructs MOBILE6 to apply weekend activity information in calculating emissions that depend on vehicle usage rates, such as engine start emissions

3. **WE EN TRI LEN DI : weentrip.d** is an input only used for the Saturday runs performed by MAG. This flag allows users to specify the fraction of weekend VMT that occurs during trips of various durations at each hour of the day. The data is input to MOBILE6 through an external data file with the file name “weentrip.d”.

4. **CALENDAR YEAR : 1995** indicates that the year analyzed is 1995.

5. **EVALUATION MONTH : 1** indicates that the month analyzed was January (where January and July are the only months available for analysis by MOBILE6). Since the period subject to analysis was December 1994, the closest month available to model was January of 1995.

6. **ALTITUDE : 1** indicates that the runs are being performed for a low-altitude region. The low altitude flag represents approximately 500 feet above sea level and the high altitude flag represents approximately 5,500 feet above sea level.

7. **HOURLY TEMPERATURES:** indicates the 24 hourly temperatures for the day being modeled, starting at 6 a.m. and ending at 5 a.m. the next morning in degrees Fahrenheit.

8. **SPEED VMT: svmta3SA.txt** indicates that the user has chosen to provide an external data file, svmta3SA.txt, that contains hourly speed distributions for both freeway and arterial roadway types

9. **FUEL RVP : 8.50** indicates that the measure of fuel volatility Reid Vapor Pressure is expected to be 8.50 pounds per square inch during the period modeled.

10. **SULFUR CONTENT : 120.0** instructs MOBILE6 that the user will supply the gasoline sulfur levels, expressed as parts per million. The runs performed for this analysis indicate a sulfur content of 120 parts per million.

11. **OXYGENATED FUELS : 0.170 0.830 0.025 0.035 1** indicates that the gasoline sold during the time period modeled is expected to have 17 percent market share of ether and a 83 percent market share of ethanol as an oxygenate additive. The average oxygen content of ether blend fuels is 2.5 percent by weight and the average oxygen content of ethanol blend fuels is 3.5 percent by weight. The number 1 indicates that there is no RVP waiver granted for alcohol based oxygenates.

Model Outputs

MOBILE6 was executed with the inputs described above to obtain a database of emission factors in grams per mile (g/mi) for exhaust CO. The database of emission factors represented emission factors split out by the vehicle classes, vehicle ages, hour of the day, roadway (facility) type on which the vehicle is driving. These outputs, in the units of grams per mile were input to the M6Link system for further processing.

ATTACHMENT ONE

MOBILE6 INPUT FILES

Attachment One contains a portion of the MOBILE6 input files for the I/M and no I/M runs for the modeling year 1994. The sample inputs reflects Area Type number 1 (central business district) and the Saturday modeling day. The I/M input appears first followed by the no I/M input.

```
MOBILE6 INPUT FILE :
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DATABASE EMISSIONS : 2222 2222
DATABASE FACILITIES: Arterial Freeway Local Ramp None
DATABASE VEHICLES  : 22222 22222222 2 222 22222222 222

POLLUTANTS         : CO

RUN DATA
I/M PROGRAM        : 1 1977 2050 1 T/O LOADED/IDLE
I/M MODEL YEARS    : 1 1967 2020
I/M VEHICLES       : 1 22222 22222222 2
I/M STRINGENCY     : 1 28.0
I/M COMPLIANCE     : 1 97.0
I/M WAIVER RATES   : 1 10.0 4.0
ANTI-TAMP PROG     :
87 75 20 22222 22222222 2 11 097. 22221112

*the tech12.d file must be located with Mobile6 execution file
*the user tech file tech12.1me should be renamed as tech12.d
*Two more I/M programs should not have overlapped motor vehicles.

REG DIST           : reg94.txt
DIESEL FRACTIONS   :
0.0030 0.0030 0.0040 0.0040 0.0050 0.0030 0.0040 0.0050 0.0060 0.0070
0.0110 0.0160 0.0280 0.0410 0.0350 0.0300 0.0210 0.0120 0.0080 0.0100
0.0210 0.0060 0.0060 0.0040 0.0040
0.0320 0.0230 0.0380 0.0300 0.0230 0.0210 0.0140 0.0110 0.0170 0.0200
0.0310 0.0400 0.0480 0.0720 0.0380 0.0310 0.0140 0.0090 0.0030 0.0050
0.0080 0.0170 0.0070 0.0040 0.0040
0.0320 0.0230 0.0380 0.0300 0.0230 0.0210 0.0140 0.0110 0.0170 0.0200
0.0310 0.0400 0.0480 0.0720 0.0380 0.0310 0.0140 0.0090 0.0030 0.0050
0.0080 0.0170 0.0070 0.0040 0.0040
0.0115 0.0111 0.0145 0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124
0.0135 0.0169 0.0209 0.0256 0.0013 0.0006 0.0011 0.0001 0.0000 0.0000
0.0000 0.0001 0.0001 0.0001 0.0001
0.0115 0.0111 0.0145 0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124
0.0135 0.0169 0.0209 0.0256 0.0013 0.0006 0.0011 0.0001 0.0000 0.0000
0.0000 0.0001 0.0001 0.0001 0.0001
0.2578 0.2515 0.3263 0.2784 0.2963 0.2384 0.2058 0.1756 0.1958 0.2726
0.2743 0.3004 0.2918 0.2859 0.0138 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000
0.7715 0.7910 0.8105 0.8068 0.8280 0.8477 0.7940 0.7488 0.7789 0.7842
0.6145 0.5139 0.5032 0.4277 0.0079 0.0000 0.0000 0.0001 0.0003 0.0010
0.0028 0.0248 0.0000 0.0000 0.0000
0.8473 0.8048 0.8331 0.7901 0.7316 0.7215 0.7158 0.5647 0.3178 0.2207
0.1968 0.1570 0.0738 0.0341 0.0414 0.0003 0.0000 0.0000 0.0000 0.0259
0.0078 0.0004 0.0090 0.0112 0.0112
0.4384 0.3670 0.4125 0.3462 0.2771 0.2730 0.2616 0.1543 0.0615 0.0383
0.0333 0.0255 0.0111 0.0049 0.0060 0.0000 0.0000 0.0000 0.0000 0.0037
0.0011 0.0001 0.0013 0.0255 0.0111
0.6078 0.5246 0.5767 0.5289 0.5788 0.5617 0.4537 0.4216 0.4734 0.4705
0.4525 0.4310 0.3569 0.3690 0.4413 0.3094 0.1679 0.1390 0.0808 0.0476
0.0365 0.0288 0.0274 0.0297 0.0297
0.8443 0.7943 0.8266 0.7972 0.8297 0.8177 0.7440 0.7184 0.7588 0.7567
0.7431 0.7261 0.6602 0.6717 0.7344 0.6107 0.4140 0.3160 0.2353 0.1489
0.1170 0.0940 0.0897 0.0966 0.0966
```

```
0.9989 0.9987 0.9989 0.9977 0.9984 0.9982 0.9979 0.9969 0.9978 0.9980
0.9979 0.9976 0.9969 0.9978 0.9982 0.9974 0.9965 0.9964 0.9949 0.9920
0.9936 0.9819 0.9812 0.9720 0.9720
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000
0.8857 0.8525 0.8795 0.9900 0.9105 0.8760 0.7710 0.7502 0.7345 0.6733
0.5155 0.3845 0.3238 0.3260 0.2639 0.0594 0.0460 0.0291 0.0240 0.0086
0.0087 0.0000 0.0000 0.0000 0.0000
SCENARIO RECORD    : I/M Scenario
WE VEH US          :
WE EN TRI LEN DI   : weentrip.d
CALENDAR YEAR      : 1995
EVALUATION MONTH   : 1
ALTITUDE           : 1
HOURLY TEMPERATURES: 41.8 41.1 41.3 46.4 54.6 61.1 69.7 72.8 74.8 75.2 73.6 65.5
                     58.8 55.6 53.2 50.8 49.8 49.0 44.8 43.4 42.7 42.2 42.5 41.7
SPEED VMT          : svmta1SA.txt
FUEL RVP           : 8.50
SULFUR CONTENT     : 120.0
OXYGENATED FUELS   : 0.170 0.830 0.025 0.035 1
END OF RUN
```

```
MOBILE6 INPUT FILE :
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DATABASE EMISSIONS : 2222 2222
DATABASE FACILITIES: Arterial Freeway Local Ramp None
DATABASE VEHICLES  : 22222 22222222 2 222 22222222 222

POLLUTANTS         : CO

RUN DATA
REG DIST           : reg94.txt
DIESEL FRACTIONS   :
0.0030 0.0030 0.0040 0.0040 0.0050 0.0030 0.0040 0.0050 0.0060 0.0070
0.0110 0.0160 0.0280 0.0410 0.0350 0.0300 0.0210 0.0120 0.0080 0.0100
0.0210 0.0060 0.0060 0.0040 0.0040
0.0320 0.0230 0.0380 0.0300 0.0230 0.0210 0.0140 0.0110 0.0170 0.0200
0.0310 0.0400 0.0480 0.0720 0.0380 0.0310 0.0140 0.0090 0.0030 0.0050
0.0080 0.0170 0.0070 0.0040 0.0040
0.0320 0.0230 0.0380 0.0300 0.0230 0.0210 0.0140 0.0110 0.0170 0.0200
0.0310 0.0400 0.0480 0.0720 0.0380 0.0310 0.0140 0.0090 0.0030 0.0050
0.0080 0.0170 0.0070 0.0040 0.0040
0.0115 0.0111 0.0145 0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124
0.0135 0.0169 0.0209 0.0256 0.0013 0.0006 0.0011 0.0001 0.0000 0.0000
0.0000 0.0001 0.0001 0.0001 0.0001
0.0115 0.0111 0.0145 0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124
0.0135 0.0169 0.0209 0.0256 0.0013 0.0006 0.0011 0.0001 0.0000 0.0000
0.0000 0.0001 0.0001 0.0001 0.0001
0.2578 0.2515 0.3263 0.2784 0.2963 0.2384 0.2058 0.1756 0.1958 0.2726
0.2743 0.3004 0.2918 0.2859 0.0138 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000
0.7715 0.7910 0.8105 0.8068 0.8280 0.8477 0.7940 0.7488 0.7789 0.7842
0.6145 0.5139 0.5032 0.4277 0.0079 0.0000 0.0000 0.0001 0.0003 0.0010
0.0028 0.0248 0.0000 0.0000 0.0000
0.8473 0.8048 0.8331 0.7901 0.7316 0.7215 0.7158 0.5647 0.3178 0.2207
0.1968 0.1570 0.0738 0.0341 0.0414 0.0003 0.0000 0.0000 0.0000 0.0259
0.0078 0.0004 0.0090 0.0112 0.0112
0.4384 0.3670 0.4125 0.3462 0.2771 0.2730 0.2616 0.1543 0.0615 0.0383
0.0333 0.0255 0.0111 0.0049 0.0060 0.0000 0.0000 0.0000 0.0000 0.0037
0.0011 0.0001 0.0013 0.0255 0.0111
0.6078 0.5246 0.5767 0.5289 0.5788 0.5617 0.4537 0.4216 0.4734 0.4705
0.4525 0.4310 0.3569 0.3690 0.4413 0.3094 0.1679 0.1390 0.0808 0.0476
0.0365 0.0288 0.0274 0.0297 0.0297
0.8443 0.7943 0.8266 0.7972 0.8297 0.8177 0.7440 0.7184 0.7588 0.7567
0.7431 0.7261 0.6602 0.6717 0.7344 0.6107 0.4140 0.3160 0.2353 0.1489
0.1170 0.0940 0.0897 0.0966 0.0966
0.9989 0.9987 0.9989 0.9977 0.9984 0.9982 0.9979 0.9969 0.9978 0.9980
0.9979 0.9976 0.9969 0.9978 0.9982 0.9974 0.9965 0.9964 0.9949 0.9920
0.9936 0.9819 0.9812 0.9720 0.9720
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000
0.8857 0.8525 0.8795 0.9900 0.9105 0.8760 0.7710 0.7502 0.7345 0.6733
0.5155 0.3845 0.3238 0.3260 0.2639 0.0594 0.0460 0.0291 0.0240 0.0086
0.0087 0.0000 0.0000 0.0000 0.0000
SCENARIO RECORD    : I/M Scenario
WE VEH US          :
WE EN TRI LEN DI   : weentrip.d
CALENDAR YEAR      : 1995
```

```
EVALUATION MONTH    : 1
ALTITUDE            : 1
HOURLY TEMPERATURES: 41.8 41.1 41.3 46.4 54.6 61.1 69.7 72.8 74.8 75.2 73.6 65.5
                     58.8 55.6 53.2 50.8 49.8 49.0 44.8 43.4 42.7 42.2 42.5 41.7
SPEED VMT           : svmta1SA.txt
FUEL RVP            : 8.50
SULFUR CONTENT      : 120.0
OXYGENATED FUELS    : 0.170 0.830 0.025 0.035 1
END OF RUN
```

App.III-ii

The M6Link System

App.III-ii contains a description of the M6Link system which is a tool that combines onroad vehicle traffic data with onroad vehicle emission factors to create an onroad vehicle emissions inventory.

The M6Link System

The M6Link system is a series of two FORTRAN-based programs that integrates travel demand modeling output from the EMME/2 and emission factors from MOBILE6 to produce estimates of total onroad vehicle emissions. The vehicle travel component of M6Link reads in the output from the travel demand models that are processed through GIS software. The output from the travel demand models reflect four times of day; a.m. peak, midday, p.m. peak, and nighttime. The outputs also reflect four vehicle classes; light duty commercial vehicles, medium duty commercial vehicles, heavy duty commercial vehicles, and all other vehicles. Other components of the data produced by the travel demand models are the coordinates of each modeled roadway link and individualized traffic estimates for that link, the facility type of the link, the area type, and more.

The vehicle travel component of M6Link reads in data produced from the travel demand models and produces vehicle miles traveled (VMT) estimates that have been changed from being link-specific to grid cell specific. The estimates have also been converted from reflecting a total for the four time periods of the day to hourly estimates.

The EMME/2 model produces estimates of vehicle trips and vehicle speeds for each modeled transportation link (roadway segment) for each of the four time periods of the day of a.m. peak (6 a.m. to 9 a.m.), midday (9 a.m. to 3 p.m.), p.m. peak (3 p.m. to 6 p.m.) and nighttime (6 p.m. to 6 a.m.). The traffic volumes for each of these time periods was split to produce hourly traffic volumes. The volumes by time period are split into hourly volumes by M6Link using hourly VMT splits from the MAG document 1998 MAG Regional Congestion Study, September 2000.

In this component of M6Link, Highway Performance Monitoring System (HPMS) factors are applied to reconcile VMT generated by the EMME/2 travel demand models with actual VMT reported by HPMS. HPMS data for the State is submitted annually to the Federal Highway Administration by the Arizona Department of Transportation. Actual HPMS VMTs for 1994 and 1995 were used to convert EMME/2 modeled VMT to HPMS-consistent values. Appendix III-iv describes the procedure used to develop HPMS factors for years after 1997 (i.e., 2015). Reconciliation of travel demand modeled VMT with HPMS is a practice recommended by EPA[31].

All VMT estimates contained in the travel demand model are generated for an average weekday. To take into account traffic volumes for a specific episode day, adjustment factors consistent with those used in the Serious Area Plan are calculated and used to convert the "typical" weekday traffic volumes into volumes for a Friday-Saturday in December. The adjustment factors of 0.9168 for December, and 1.0405 for Friday and 0.8280 for Saturday, are multiplied to yield an adjustment factor of 0.9539 for a Friday in December and 0.7591 for a Saturday in December. These factors and the factors for all day of the week and month combinations are documented in the August 7, 1996 MAG memo from Cathy Arthur to Roger Herzog titled Conversion of Modeled Traffic Volumes to a Specific Month and Day of the Year. This memo may be found in Exhibit 3 of the March 2001 Revised CO Technical Support Document.

The highway network VMT data, created with the EMME/2 transportation model, that is read in by M6Link reemerges from M6Link in the form of a VMT table. The VMT table that is output by M6Link includes the estimated VMT for each grid cell, for each hour, and for each combination of area type, facility type, and vehicle class. This file includes individual VMT estimates for approximately two million area type/hour/vehicle class/grid cell/facility type combinations. Each of these VMT estimates is combined with an emissions factor (in grams per VMT) in the second portion of M6Link.

There are several inputs required by the emissions portion of M6Link. In addition to the very detailed outputs of the vehicle travel component of M6Link, other inputs include the emission factor outputs from MOBILE6 in the database format, a job file that includes information such as the year that is being modeled and the names of the MOBILE6 files to use, and a file that assists in converting the 28 vehicle classes considered by the MOBILE6 model into the four classes included in the travel demand models. The MOBILE6 outputs that reflect the I/M scenario and the outputs that reflect the non-I/M scenario reside in different electronic files. The program reads in the I/M and non-I/M emission factor for each scenario and weights them internally to produce a single emission factor for each area type/vehicle type/facility type/hour combination.

The aforementioned conversion between vehicle classes is needed because the MOBILE6 model outputs emission factors as one of 28 vehicle classes as described on page 13 in the User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, EPA420-R-02-001, January 2002 which may be found at the web site http://www.epa.gov/otaq/models/mobile6/r02001.pdf. Conversely, the EMME/2 transportation model produces estimates of vehicle trips in four categories; commercial light duty vehicles, commercial medium duty vehicles, commercial heavy duty vehicles, and all other vehicles. Using data developed in the February 1992 Arizona Department of Transportation report FHWA-AZ92-314 Development of an Urban Truck Travel Model for the Phoenix Metropolitan Area, a series of factors were developed that are used to appropriately weight the VMT ratios from the 28 vehicle classes into the four vehicle classes described above.

Additionally, while the MOBILE6 model produces estimates of cold starts emission factors independent of facility type, cold start emissions are generally more likely to occur on smaller roadways such as arterials and local roadways. It is unlikely that vehicles would produce cold start emissions while on a freeway since it would generally take several minutes to reach a freeway from where the vehicle had been at rest (such as a home or workplace). As such, cold start emissions have been applied to all roadway types except for freeways and freeway ramps to improve the spatial allocation of these emissions.

Using the emission factors output by MOBILE6, M6Link calculates and spatially allocate the onroad mobile emissions in the modeling domain. The emissions are spatially allocated into one square mile cells, and the modeling domain consists of 33 grid cells in the east-west direction and 24 grid cells in the north-south direction. The hourly emissions output from M6Link are processed through MEDEXPLORA, which is a component of the EXPLORA modeling system used in the Serious Area CO Plan analysis, to provide UAM-ready input files. Control measures that result in across-the-board adjustments are applied to the UAM-ready input files through the EMSCOR utility.

The M6Link program is run using a control file to provide needed inputs. The inputs to a M6Link run performed for this analysis, in particular the 1994 analysis for Friday, are described below. The inputs to a M6Link run for the 2015 scenario would follow the same pattern.

1. **/VERSION/**

   1.2

   identifies the M6Link control file as being appropriate for use with a particular version of the model. This run was performed with the M6Link executable version 1.2.

2. **/XCELLS/**

   33

   instructs the M6Link model to include 33 grid cells of emissions in the east-west direction in the active modeling domain.

3. **/YCELLS/**

   24

   instructs the M6Link model to include 24 grid cells of emissions in the north-south direction in the active modeling domain.

4. **/YEAR/**

   1994

   instructs the M6Link model to condense the 28 MOBILE6 vehicle class emission factors to four vehicle classes using weighting factors appropriate for the 2015 time period. The weighting factors differ over time due to changes in overall fleet characteristics.

5. **/MOBILEIN/**

   WD1694A1.TB1
   WD1694A2.TB1
   WD1694A3.TB1
   WD1694A4.TB1
   WD1694A5.TB1

ND1694A1.TB1
ND1694A2.TB1
ND1694A3.TB1
ND1694A4.TB1
ND1694A5.TB1

instructs the M6Link model which ten MOBILE6 output files to access to derive emission factors appropriate for the particular analysis where the first five MOBILE6 files reflect an I/M program present and area types one through five and the second five MOBILE6 files reflect no I/M program

6. **/MESSAGES/**
   YES
   YES
   YES
   YES

   instructs the M6Link model to include all four optional message output files available.

7. **/LINK FILE/**
   linksplit.txt.Fri

   instructs the M6Link model to access the file named linksplit.txt.Fri as containing the transportation modeling data appropriate for use in developing emission totals.

8. **/WEIGHTS/**
   88
   12

   instructs the M6Link model to weight the MOBILE6 factors as 88.0 percent of vehicles of the appropriate age and class participate in the I/M program and the remaining 12.0 percent do not.

9. **/FACTORS/**
   1.0060
   1.0044
   1.0068
   etc...

   instructs the M6Link model to apply an adjustment factor to hourly vehicle miles of travel estimates.

10. **/MC IM /**

NO

instructs the M6Link model to not apply credit for the motorcycle component of the inspection and maintenance program.

App.III-iii

Development of the Spatial Surrogates

DEVELOPMENT OF SPATIAL ALLOCATION SURROGATES FOR THE SERIOUS AREA CO SIP EMISSIONS INVENTORY

1. Background

Since the Urban Airshed Model (UAM) predicts carbon monoxide and ozone concentrations at grid level, it must be supplied with the same degree of grid-level emissions data. The amount of efforts to derive grid-level emissions varies depending on the type of emission source. Two methods are generally used to allocate emissions to grid cells: One method is to directly obtain emissions for each grid cell and the other is to use spatial surrogates of emission levels (e.g., the number of houses or type of land use). The former is the most accurate method to obtain grid-level emissions, but it is absolutely dependent upon available resources such as time, money, and data. It has been applied to point or onroad mobile source emissions since existing databases of point and onroad mobile source emissions contain location data for each source or each link, allowing direct assignment to the appropriate grid cells. The latter assumes that emissions from each source behave spatially in the same manner as the spatial surrogate. It has been used for the spatial allocation of area and nonroad mobile source emissions because specific location data for each area or nonroad mobile source are not available. Fifteen categories of spatial surrogates shown in Table 1 were developed for area and nonroad mobile source emissions in conjunction with the serious area CO SIP UAM modeling. A typical spatial surrogate is defined as the ratio of a grid-level to the county-level or CO nonattainment land use area. This document describes the development of spatial surrogates to spatially allocate area and nonroad mobile source emissions to the CO modeling domain. The result of this effort is a gridded spatial surrogate file for use with the GRDEM module of EPS2.0.

2. Development Procedures

2.1 CO Modeling Domain

Modeling domain and gridded nonattainment area for CO were developed using the GENERATE ARC command of ARC/INFO. The origin of the modeling domain is located at 378,405 meters and 3,682,368 meters in UTM zone 12. The gridded domain has 33 grid cells in x direction (easting) and 24 grid cells in y direction (northing) and each grid cell size is 1,609 meters by 1,609 meters. The modeling domain is smaller than the CO nonattainment area.

2.2 Spatial Surrogates

Fifteen spatial surrogates were developed for the CO nonattainment area since area and nonroad mobile source emissions inventories were developed for the CO nonattainment area. Since the CO nonattainment area is bigger than the CO modeling domain, the GRDEM module of the EPS2.0 chops off emissions outside of the CO modeling domain. Categories and data sources used to develop spatial surrogates are shown in Table 1.

To develop housing spatial surrogate 2000 census and census block data were intersected by the gridded CO nonattainment area using INTERSECT command in PC ArcView “xtools” extension.
Since 2000 census and block data provide for the total number of houses by census block, houses per unit area for each census block were calculated. The houses per unit area by census block were multiplied by census block areas for both grid cell and the CO nonattainment area. The total house numbers for grid cell and the nonattainment area were extracted to calculate the ratio of the number of houses in grid cell to the number of houses in the nonattainment area.

Industrial and non-industrial spatial surrogates were based on the 1995 land use data. Industrial and non-industrial areas for the CO nonattainment area and grid cells were extracted by intersecting the 1995 land use with the gridded CO nonattainment area. Industrial land use category in the 1995 land use data was used for the industrial spatial surrogate while land use categories such as business park, commercial retail center, warehouse/distribution center, hotel, model, resort, retail center, large assembly area, offices and public facility were included for the non-industrial spatial surrogate.

The spatial surrogates for undeveloped total and developed total were developed based on the 1995 land use and gridded CO nonattainment area. The undeveloped total spatial surrogate was based on the 1995 land use code #24. The developed total surrogate is based on 1995 land use codes #1 through 17. The 1995 land use was intersected with the gridded CO nonattainment area. The acres of the appropriate land use categories by grid cell were extracted to calculate the ratio of grid area to the nonattainment area. Airport, golf course, and water spatial surrogates were developed based on the 1995 land use intersected with the gridded CO nonattainment area.

The 1990 land use contains three categories of agricultural land: Agriculture-Citrus, Agriculture-Other Crops, and Agriculture-Stockyards. The 1995 land use contains only total agriculture. In an effort to maintain the spatial distinction among agricultural land uses, the updated agricultural surrogates were created using the change in total agricultural land from 1990 to 1995 and applying the change to the 1990 agriculture land use categories. The updated agricultural surrogates are Agricultural-Stockyard and Agricultural-Other Crops. The total acres of agriculture land within each grid cell were extracted for 1990 and 1995. The difference in total agricultural acres per grid cell between 1990 and 1995 was divided by the total 1990 agricultural acres per grid cell. This fractional change was subtracted from one. The difference was multiplied by the 1990 Agricultural Stockyard acres per grid cell and 1990 Agricultural-Other Crops acres per grid cell to calculate the 1995 Agriculture-Stockyard acres per grid cell and the 1995 Agricultural-Other Crops acres per grid cell, respectively.

Construction spatial surrogates such as residential, commercial and total construction were developed using the following databases: 1996 TAZ, 1995 land use, the MAG general plan and TAZPRJ97.DBF. To estimate the amount of development that will occur between 1995 and 2000, the increase in households per TAZ was divided by 7 household per acre and the increase in total employment per TAZ was divided by 20 employees per acre. This calculation estimates the new household acres and employment acres per TAZ. The number of acres of vacant land from the 1995 land use coverage that were also coded as residential or commercial acreage in the MAG General Plan were calculated by TAZ. This calculation represents the maximum new acres of residential and commercial use per TAZ. The new household acres and employment acres per TAZ were converted to the new household acres and employment acres per grid cells. The new household acres were used as the spatial surrogate for residential construction. The new employment acres were used as the spatial surrogate for commercial construction. The sum of new household and employment acres were used as the total construction spatial surrogate.

The 1990 land use coverage was used to develop the remaining spatial surrogates including non-developable forest and railroad. The 1990 land use was intersected with gridded CO nonattainment area and the acres of non-developable forest and railroad by each grid cell were extracted from the intersected coverage.

The separately generated 15 spatial surrogates were combined into one file and formatted by a FORTRAN program for use in the GRDEM module of EPS2.0.

Table 1. Spatial Surrogate Codes and Categories

Code	Categories	Data Source
1	Housing	2000 Census Data
2	Industrial	1995 Land Use
3	Non-industrial	1995 Land Use
4	Undeveloped Total	1995 Land Use
5	Developed Total	1995 Land Use
6	Residential Construction	1995 Land Use + 1996 TAZ + General Plan
7	Agriculture - Stockyards	1990 Land Use + 1995 Land Use
8	Agriculture - Other Crops	1990 Land Use + 1995 Land Use
9	Commercial Construction	1995 Land Use + 1996 TAZ + General Plan
10	Non-developable Forest	1990 Land Use
11	Railroad	1990 Land Use
12	Water	1995 Land Use
13	Golf Course	1995 Land Use

14	Total Construction	1995 Land Use + 1996 TAZ + General Plan + TAZPRJ97.dbf
15	Airport	1995 Land Use

Table 2. CO Spatial Surrogate Assignments

Area Source Category	Spatial Surrogate Code	Source Category Description
2102000000	2	Industrial; External Combustion
2102006000	2	Industrial; Natural Gas; External Combustion
2103006000	3	Com/Inst; Nat Gas; External Combustion
2104006000	1	Residential; Nat Gas; External Combustion
2104008000	1	Residential; Barbecues/Firepits
2104008001	1	Residential; Fireplaces
2104008010	1	Residential; Wood Stoves
2199000000	5	Total Area; External Combustion
2260001010	4	Off-Road Motorcycles, Gasoline, 2-stroke, Mobile
2260001030	4	All Terrain Vehicles (ATVs), Gasoline, 2-stroke, Mobile
2260001040	4	Minibikes, Gasoline, 2-stroke, Mobile
2260001050	13	Golf Carts, Gasoline, 2-stroke, Mobile
2260001060	5	Specialty Vehicles Carts, Gasoline, 2-stroke, Mobile
2260002003	14	Asphalt Pavers, Gasoline, 2-stroke, Mobile
2260002006	14	Tampers/Rammers, Gasoline, 2-stroke, Mobile
2260002009	14	Plate Compactors, Gasoline, 2-stroke, Mobile
2260002012	14	Concrete Pavers, Gasoline, 2-stroke, Mobile
2260002015	14	Rollers, Gasoline, 2-stroke, Mobile
2260002018	14	Scrapers, Gasoline, 2-stroke, Mobile
2260002021	14	Paving Equipment, Gasoline, 2-stroke, Mobile
2260002024	14	Surfacing Equipment, Gasoline, 2-stroke, Mobile
2260002027	14	Signal Boards, Gasoline, 2-stroke, Mobile
2260002030	14	Trenchers, Gasoline, 2-stroke, Mobile
2260002033	14	Bore/Drill Rigs, Gasoline, 2-stroke, Mobile
2260002036	14	Excavators, Gasoline, 2-stroke, Mobile
2260002039	14	Concrete/Industrial Saws, Gasoline, 2-stroke, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2260002042	14	Cement and Mortar Mixers, Gasoline, 2-stroke, Mobile
2260002045	14	Cranes, Gasoline, 2-stroke, Mobile
2260002048	14	Graders, Gasoline, 2-stroke, Mobile
2260002051	14	Off-Highway Trucks, Gasoline, 2-stroke, Mobile
2260002054	14	Crushing/Proc. Equipment, Gasoline, 2-stroke, Mobile
2260002057	14	Rough Terrain Forklifts, Gasoline, 2-stroke, Mobile
2260002060	14	Rubber Tired Loaders, Gasoline, 2-stroke, Mobile
2260002063	14	Rubber Tired Dozers, Gasoline, 2-stroke, Mobile
2260002066	14	Tractors/Loaders/Backhoes, Gasoline, 2-stroke, Mobile
2260002069	14	Crawler Tractors, Gasoline, 2-stroke, Mobile
2260002072	14	Skid Steer Loaders, Gasoline, 2-stroke, Mobile
2260002075	14	Off-Highway Tractors, Gasoline, 2-stroke, Mobile
2260002078	14	Dumpers/Tenders, Gasoline, 2-stroke, Mobile
2260002081	14	Other Construction Equipment, Gasoline, 2-stroke, Mobile
2260003010	2	Aerial Lifts, Gasoline, 2-stroke, Mobile
2260003020	2	Forklifts, Gasoline, 2-stroke, Mobile
2260003030	2	Sweepers/Scrubbers, Gasoline, 2-stroke, Mobile
2260003040	2	Other General Industrial Equipment, Gasoline, 2-stroke, Mobile
2260003050	2	Other Material Handling Equipment, Gasoline, 2-stroke, Mobile
2260004010	5	Lawn Mowers, Gasoline, 2-stroke, Mobile
2260004015	5	Tillers <5 HP, Gasoline, 2-stroke, Mobile
2260004020	5	Chainsaws <4 HP, Gasoline, 2-stroke, Mobile
2260004025	5	Trimmers/Edgers/Brush Cutters, Gasoline, 2-stroke, Mobile
2260004030	5	Leaf Blowers/Vacuums, Gasoline, 2-stroke, Mobile
2260004040	5	Rear Engine Riding Mowers, Gasoline, 2-stroke, Mobile
2260004045	5	Front Mowers, Gasoline, 2-stroke, Mobile
2260004050	5	Shredders <5 HP, Gasoline, 2-stroke, Mobile
2260004055	5	Lawn & Garden Tractors, Gasoline, 2-stroke, Mobile
2260004060	5	Wood Splitters, Gasoline, 2-stroke, Mobile
2260004065	5	Chippers/Stump Grinders, Gasoline, 2-stroke, Mobile
2260004070	5	Commercial Turf Equipment, Gasoline, 2-stroke, Mobile
2260004075	5	Other Lawn & Garden Equipment, Gasoline, 2-stroke, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2260005010	8	2-Wheel Tractors, Gasoline, 2-stroke, Mobile
2260005015	8	Agricultural Tractors, Gasoline, 2-stroke, Mobile
2260005020	8	Combines, Gasoline, 2-stroke, Mobile
2260005025	8	Balers, Gasoline, 2-stroke, Mobile
2260005030	8	Agricultural Mowers, Gasoline, 2-stroke, Mobile
2260005035	8	Sprayers, Gasoline, 2-stroke, Mobile
2260005040	8	Tillers >5 HP, Gasoline, 2-stroke, Mobile
2260005045	8	Swathers, Gasoline, 2-stroke, Mobile
2260005050	8	Hydro Power Units, Gasoline, 2-stroke, Mobile
2260005055	8	Other Agricultural Equipment, Gasoline, 2-stroke, Mobile
2260006005	3	Generator Sets <50 HP, Gasoline, 2-stroke, Mobile
2260006010	3	Pumps <50 HP, Gasoline, 2-stroke, Mobile
2260006015	3	Air Compressors <50 HP, Gasoline, 2-stroke, Mobile
2260006020	3	Gas Compressors <50 HP, Gasoline, 2-stroke, Mobile
2260006025	3	Welders <50 HP, Gasoline, 2-stroke, Mobile
2260006030	3	Pressure Washers <50 HP, Gasoline, 2-stroke, Mobile
2260007005	10	Chainsaws >4 HP, Gasoline, 2-stroke, Mobile
2260007010	10	Shredders >5 HP, Gasoline, 2-stroke, Mobile
2260007015	10	Skidders, Gasoline, 2-stroke, Mobile
2260007020	10	Fellers/Bunchers, Gasoline, 2-stroke, Mobile
2260008005	15	Aircraft Support Equipment, Gasoline, 2-stroke, Mobile
2260008010	15	Terminal Tractors, Gasoline, 2-stroke, Mobile
2265001010	4	Off-Road Motorcycles, Gasoline, 4-stroke, Mobile
2265001030	4	All Terrain Vehicles (ATVs), Gasoline, 4-stroke, Mobile
2265001040	4	Minibikes, Gasoline, 4-stroke, Mobile
2265001050	13	Golf Carts, Gasoline, 4-stroke, Mobile
2265001060	5	Specialty Vehicles Carts, Gasoline, 4-stroke, Mobile
2265002003	14	Asphalt Pavers, Gasoline, 4-stroke, Mobile
2265002006	14	Tampers/Rammers, Gasoline, 4-stroke, Mobile
2265002009	14	Plate Compactors, Gasoline, 4-stroke, Mobile
2265002012	14	Concrete Pavers, Gasoline, 4-stroke, Mobile
2265002015	14	Rollers, Gasoline, 4-stroke, Mobile
2265002018	14	Scrapers, Gasoline, 4-stroke, Mobile
2265002021	14	Paving Equipment, Gasoline, 4-stroke, Mobile
2265002024	14	Surfacing Equipment, Gasoline, 4-stroke, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2265002027	14	Signal Boards, Gasoline, 4-stroke, Mobile
2265002030	14	Trenchers, Gasoline, 4-stroke, Mobile
2265002033	14	Bore/Drill Rigs, Gasoline, 4-stroke, Mobile
2265002036	14	Excavators, Gasoline, 4-stroke, Mobile
2265002039	14	Concrete/Industrial Saws, Gasoline, 4-stroke, Mobile
2265002042	14	Cement and Mortar Mixers, Gasoline, 4-stroke, Mobile
2265002045	14	Cranes, Gasoline, 4-stroke, Mobile
2265002048	14	Graders, Gasoline, 4-stroke, Mobile
2265002051	14	Off-Highway Trucks, Gasoline, 4-stroke, Mobile
2265002054	14	Crushing/Proc. Equipment, Gasoline, 4-stroke, Mobile
2265002057	14	Rough Terrain Forklifts, Gasoline, 4-stroke, Mobile
2265002060	14	Rubber Tired Loaders, Gasoline, 4-stroke, Mobile
2265002063	14	Rubber Tired Dozers, Gasoline, 4-stroke, Mobile
2265002066	14	Tractors/Loaders/Backhoes, Gasoline, 4-stroke, Mobile
2265002069	14	Crawler Tractors, Gasoline, 4-stroke, Mobile
2265002072	14	Skid Steer Loaders, Gasoline, 4-stroke, Mobile
2265002075	14	Off-Highway Tractors, Gasoline, 4-stroke, Mobile
2265002078	14	Dumpers/Tenders, Gasoline, 4-stroke, Mobile
2265002081	14	Other Construction Equipment, Gasoline, 4-stroke, Mobile
2265003010	2	Aerial Lifts, Gasoline, 4-stroke, Mobile
2265003020	2	Forklifts, Gasoline, 4-stroke, Mobile
2265003030	2	Sweepers/Scrubbers, Gasoline, 4-stroke, Mobile
2265003040	2	Other General Industrial Equipment, Gasoline, 4-stroke, Mobile
2265003050	2	Other Material Handling Equipment, Gasoline, 4-stroke, Mobile
2265004010	5	Lawn Mowers, Gasoline, 4-stroke, Mobile
2265004015	5	Tillers <5 HP, Gasoline, 4-stroke, Mobile
2265004020	5	Chainsaws <4 HP, Gasoline, 4-stroke, Mobile
2265004025	5	Trimmers/Edgers/Brush Cutters, Gasoline, 4-stroke, Mobile
2265004030	5	Leaf Blowers/Vacuums, Gasoline, 4-stroke, Mobile
2265004040	5	Rear Engine Riding Mowers, Gasoline, 4-stroke, Mobile
2265004045	5	Front Mowers, Gasoline, 4-stroke, Mobile
2265004050	5	Shredders <5 HP, Gasoline, 4-stroke, Mobile
2265004055	5	Lawn & Garden Tractors, Gasoline, 4-stroke, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2265004060	5	Wood Splitters, Gasoline, 4-stroke, Mobile
2265004065	5	Chippers/Stump Grinders, Gasoline, 4-stroke, Mobile
2265004070	5	Commercial Turf Equipment, Gasoline, 4-stroke, Mobile
2265004075	5	Other Lawn & Garden Equipment, Gasoline, 4-stroke, Mobile
2265005010	8	2-Wheel Tractors, Gasoline, 4-stroke, Mobile
2265005015	8	Agricultural Tractors, Gasoline, 4-stroke, Mobile
2265005020	8	Combines, Gasoline, 4-stroke, Mobile
2265005025	8	Balers, Gasoline, 4-stroke, Mobile
2265005030	8	Agricultural Mowers, Gasoline, 4-stroke, Mobile
2265005035	8	Sprayers, Gasoline, 4-stroke, Mobile
2265005040	8	Tillers >5 HP, Gasoline, 4-stroke, Mobile
2265005045	8	Swathers, Gasoline, 4-stroke, Mobile
2265005050	8	Hydro Power Units, Gasoline, 4-stroke, Mobile
2265005055	8	Other Agricultural Equipment, Gasoline, 4-stroke, Mobile
2265006005	2	Generator Sets <50 HP, Gasoline, 4-stroke, Mobile
2265006010	2	Pumps <50 HP, Gasoline, 4-stroke, Mobile
2265006015	2	Air Compressors <50 HP, Gasoline, 4-stroke, Mobile
2265006020	2	Gas Compressors <50 HP, Gasoline, 4-stroke, Mobile
2265006025	2	Welders <50 HP, Gasoline, 4-stroke, Mobile
2265006030	2	Pressure Washers <50 HP, Gasoline, 4-stroke, Mobile
2265007005	10	Chainsaws >4 HP, Gasoline, 4-stroke, Mobile
2265007010	10	Shredders >5 HP, Gasoline, 4-stroke, Mobile
2265007015	10	Skidders, Gasoline, 4-stroke, Mobile
2265007020	10	Fellers/Bunchers, Gasoline, 4-stroke, Mobile
2265008005	15	Aircraft Support Equipment, Gasoline, 4-stroke, Mobile
2265008010	15	Terminal Tractors, Gasoline, 4-stroke, Mobile
2270001010	4	Off-Road Motorcycles, Diesel, Mobile
2270001030	4	All Terrain Vehicles (ATVs), Diesel, Mobile
2270001040	4	Minibikes, Diesel, Mobile
2270001050	13	Golf Carts, Diesel, Mobile
2270001060	5	Specialty Vehicles Carts, Diesel, Mobile
2270002003	14	Asphalt Pavers, Diesel, Mobile
2270002006	14	Tampers/Rammers, Diesel, Mobile
2270002009	14	Plate Compactors, Diesel, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2270002012	14	Concrete Pavers, Diesel, Mobile
2270002015	14	Rollers, Diesel, Mobile
2270002018	14	Scrapers, Diesel, Mobile
2270002021	14	Paving Equipment, Diesel, Mobile
2270002024	14	Surfacing Equipment, Diesel, Mobile
2270002027	14	Signal Boards, Diesel, Mobile
2270002030	14	Trenchers, Diesel, Mobile
2270002033	14	Bore/Drill Rigs, Diesel, Mobile
2270002036	14	Excavators, Diesel, Mobile
2270002039	14	Concrete/Industrial Saws, Diesel, Mobile
2270002042	14	Cement and Mortar Mixers, Diesel, Mobile
2270002045	14	Cranes, Diesel, Mobile
2270002048	14	Graders, Diesel, Mobile
2270002051	14	Off-Highway Trucks, Diesel, Mobile
2270002054	14	Crushing/Proc. Equipment, Diesel, Mobile
2270002057	14	Rough Terrain Forklifts, Diesel, Mobile
2270002060	14	Rubber Tired Loaders, Diesel, Mobile
2270002063	14	Rubber Tired Dozers, Diesel, Mobile
2270002066	14	Tractors/Loaders/Backhoes, Diesel, Mobile
2270002069	14	Crawler Tractors, Diesel, Mobile
2270002072	14	Skid Steer Loaders, Diesel, Mobile
2270002075	14	Off-Highway Tractors, Diesel, Mobile
2270002078	14	Dumpers/Tenders, Diesel, Mobile
2270002081	14	Other Construction Equipment, Diesel, Mobile
2270003010	2	Aerial Lifts, Diesel, Mobile
2270003020	2	Forklifts, Diesel, Mobile
2270003030	2	Sweepers/Scrubbers, Diesel, Mobile
2270003040	2	Other General Industrial Equipment, Diesel, Mobile
2270003050	2	Other Material Handling Equipment, Diesel, Mobile
2270004010	5	Lawn Mowers, Diesel, Mobile
2270004015	5	Tillers <5 HP, Diesel, Mobile
2270004020	5	Chainsaws <4 HP, Diesel, Mobile
2270004025	5	Trimmers/Edgers/Brush Cutters, Diesel, Mobile
2270004030	5	Leaf Blowers/Vacuums, Diesel, Mobile
2270004040	5	Rear Engine Riding Mowers, Diesel, Mobile

Table 2. CO Spatial Surrogate Assignments (Continued)

2270004045	5	Front Mowers, Diesel, Mobile
2270004050	5	Shredders <5 HP, Diesel, Mobile
2270004055	5	Lawn & Garden Tractors, Diesel, Mobile
2270004060	5	Wood Splitters, Diesel, Mobile
2270004065	5	Chippers/Stump Grinders, Diesel, Mobile
2270004070	5	Commercial Turf Equipment, Diesel, Mobile
2270004075	5	Other Lawn & Garden Equipment, Diesel, Mobile
2270005010	8	2-Wheel Tractors, Diesel, Mobile
2270005015	8	Agricultural Tractors, Diesel, Mobile
2270005020	8	Combines, Diesel, Mobile
2270005025	8	Balers, Diesel, Mobile
2270005030	8	Agricultural Mowers, Diesel, Mobile
2270005035	8	Sprayers, Diesel, Mobile
2270005040	8	Tillers >5 HP, Diesel, Mobile
2270005045	8	Swathers, Diesel, Mobile
2270005050	8	Hydro Power Units, Diesel, Mobile
2270005055	8	Other Agricultural Equipment, Diesel, Mobile
2270006005	3	Generator Sets <50 HP, Diesel, Mobile
2270006010	3	Pumps <50 HP, Diesel, Mobile
2270006015	3	Air Compressors <50 HP, Diesel, Mobile
2270006020	3	Gas Compressors <50 HP, Diesel, Mobile
2270006025	3	Welders <50 HP, Diesel, Mobile
2270006030	3	Pressure Washers <50 HP, Diesel, Mobile
2270007005	10	Chainsaws >4 HP, Diesel, Mobile
2270007010	10	Shredders >5 HP, Diesel, Mobile
2270007015	10	Skidders, Diesel, Mobile
2270007020	10	Fellers/Bunchers, Diesel, Mobile
2270008005	15	Aircraft Support Equipment, Diesel, Mobile
2270008010	15	Terminal Tractors, Diesel, Mobile
2282005005	12	Pleasure Craft; Gasoline, 2-stroke Inboard
2282005010	12	Pleasure Craft; Gasoline, 2-stroke Outboard
2282005015	12	Pleasure Craft; Gasoline, 2-stroke Sterndrive
2282005020	12	Pleasure Craft; Gasoline, 2-stroke Sailboat Aux. Inboard
2282005025	12	Pleasure Craft; Gasoline, 2-stroke Sailboat Aux. Outboard
2282010005	12	Pleasure Craft; Gasoline, 4-stroke Inboard

Table 2. CO Spatial Surrogate Assignments (Continued)

2282010010	12	Pleasure Craft; Gasoline, 4-stroke Outboard
2282010015	12	Pleasure Craft; Gasoline, 4-stroke Sterndrive
2282010020	12	Pleasure Craft; Gasoline, 4-stroke Sailboat Aux. Inboard
2282010025	12	Pleasure Craft; Gasoline, 4-stroke Sailboat Aux. Outboard
2282020005	12	Pleasure Craft; Diesel Inboard
2282020010	12	Pleasure Craft; Diesel Outboard
2282020015	12	Pleasure Craft; Diesel Sterndrive
2282020020	12	Pleasure Craft; Diesel Sailboat Aux. Inboard
2282020025	12	Pleasure Craft; Diesel Sailboat Aux. Outboard
2285002005	11	Railroads Locomotives
2285002010	11	Railroads Yard
2302002000	5	Charbroiling
2311010000	6	Residential Construction
2311000040	5	Unpaved Parking lots
2311000070	14	Construction Trackout
2311020000	9	Commercial Construction
2401001000	14	Surface Coating -Architectural Coatings
2401005000	2	Surface Coating-Auto Refinishing
2401008000	5	Surface Coating-Traffic Markings
2401010000	2	Surface Coating-Fabric Products
2401015000	2	Surface Coating-Factory Finished Wood
2401020000	2	Surface Coating-Wood Furniture
2401025000	2	Surface Coating-Metal Furniture
2401030000	2	Surface Coating-Papers
2401035000	2	Surface Coating-Plastic Products
2401045000	2	Surface Coating- Metal Coils
2401050000	2	Surface Coating-Misc. Finished Metals
2401055000	2	Surface Coating-Machinery and Equipment
2401060000	2	Surface Coating-Large Appliances
2401075000	15	Surface Coating-Aircraft Solvent Utilization
2401080000	2	Surface Coating-Marines
2401090000	2	Surface Coating-Misc. Manufacturing
2401100000	2	Surface Coating-Industrial Maintenance Coating
2401200000	2	Surface Coating-Other Specific Purpose Coating
2415000000	2	Degreasing -Solvent Utilization

Table 2. CO Spatial Surrogate Assignments (Continued)

2415045000	2	Degreasing-Misc. Manufacturing
2420000370	3	All Processes-Drying Cleaning
2425000000	3	Graphic Arts Solvent Utilization
2440000000	2	Solvent Utilization - Misc. Industrial
2461021000	14	Misc. Non-Industrial: Cutback Asphalt
2461022000	14	Misc. Non-Industrial: Emulsified Asphalt
2461023000	14	Misc. Non-Industrial-Asphalt Roofing
2461800000	8	Misc. Non-Industrial-Pestcide Application
2461900000	3	Misc. Non-Industrial-Misc. Products-NEC
2465000000	1	Misc. Non-Industrial-Consumer Solvent Use
2501050120	3	Bulk Stations Terminals-Breathing Loss Gasoline
2501060051	5	Gasoline Service Stations- Tank Truck Unloading
2501060053	5	Gasoline Service Stations-Tank Truck Unloading
2501060100	5	Gasoline Service Stations-Vehicle Refueling
2501060201	5	Gasoline Service Stations-Underground Tank Breathing Losses
2501995180	15	Local Storage-Only for Airport AV Gasoline
2505000900	3	Tank Truck Cleaning
2505030120	5	Tank Truck in Transit
2510000000	2	Organic Chemical Storage and Transport
2601000000	2	On-Site Incineration Waste Disposal
2610000000	5	Open Burning Waste Disposal
2620030000	3	Landfills -Municipal
2630020000	3	Wastewater Treatment -Public Owned
2660000000	5	Leaking -Underground Storage Tanks
2701000000	8	Biogenic-natural Sources
2701400000	8	Biogenic
2801000000	8	Agricutural Production - Crops
2801000003	8	Agriculture - Crops; Tilling
2801000005	8	Agriculture - Crops; Harvesting
2805000000	7	Agriculture - Livestock
2805001000	7	Agriculture - Livestock; Beef Cattle Feedlots
2810000000	5	Other Combustion
2810030000	5	Other Combustion- Structure Fires
2810050000	5	Other Combustion-Motor Vehicle Fire

Table 2. CO Spatial Surrogate Assignments (Continued)

2810001000	10	Forest Wildfires

App.III-iv

HPMS Reconciliation Factors

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

November 18, 2002

Ms. Lindy Bauer
Environmental Manager
Maricopa Association of Governments
302 N. 1st Avenue, Suite 300
Phoenix, AZ 85003

Dear Lindy:

Earlier this year I received a letter describing the methodology MAG has developed to reconcile vehicle miles of travel (VMT) output by the MAG EMME/2 transportation models with VMT estimates from the Highway Performance Monitoring System (HPMS). The letter requested approval from EPA Region IX to apply the HPMS reconciliation methodology in preparing on-road mobile source emissions for future air quality plans and transportation conformity analyses.

Reconciliation of network-based travel model VMT with HPMS is recommended in EPA's *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. It is also required in EPA's Transportation Conformity Rule, Section 93.122(b)(3), for nonattainment areas such as Maricopa County that are classified as Serious for ozone and carbon monoxide.

I reviewed the MAG HPMS reconciliation methodology, which is based on 5,000 traffic counts and the latest MAG transportation model validation for the year 1998. On March 11, 2002, I called Cathy Arthur of your staff and approved the methodology for use in future transportation conformity analyses and air quality plans, including the carbon monoxide and ozone maintenance plans.

This letter confirms that EPA Region IX has approved the HPMS reconciliation methodology documented in your letter with attachments of January 8, 2002.

Sincerely,

Frances Wicher
Office of Air Planning

DERIVATION OF HPMS RECONCILIATION FACTORS

1998 Transportation Model VMT[1] By Facility Type (Based on AWDT[2])	Urbanized Area[3]	Donut Area[3]
#1 - Freeways	14,329,934	2,140,463
#2 - Expressways	441,383	1,196,360
#3 - Collectors	1,996,676	426,879
#4 - 6-Leg Arterials	748,358	0
#5 - Centroids	6,059,922	765,899
#6 - Arterials	33,374,324	3,759,702
#7 - Ramps (Unmetered)	628,886	53,949
#8 - Metered Ramps	31,085	2,024
#9 - Penalty Links	12,112	1,952
#10 - HOV Lanes	444,901	0
TOTAL	58,067,581	8,347,228

1998 HPMS VMT - Urbanized Area #33 By Functional System (Based on AADT[4])	Urbanized Area[5]	Conversion to AWDT[6]
Interstate	7,526,000	8,270,330
Other Freeways	7,477,000	8,216,484
Other Principal Arterial	18,062,000	19,848,352
Minor Arterial	9,229,000	10,141,758
Collector	5,099,000	5,603,297
Local	5,158,000	5,668,132
TOTAL	52,551,000	57,748,353

1998 HPMS VMT - Donut Area #33 By Functional System (Based on AADT[4])	Donut Area[5,7]	Conversion to AWDT[6]
Principal Arterial	2,328,000	2,558,242
Minor Arterial and (Major) Collector	2,238,000	2,459,341
Minor Collector and Local	415,000	456,044
TOTAL	4,981,000	5,473,627

[1]Based on the 1998LR3 EMME/2 validation traffic assignment.
[2]AWDT = Average Weekday Traffic (average daily traffic on a typical weekday).
[3]ArcInfo GIS software was used to identify EMME/2 links inside the HPMS urbanized and donut areas.
[4]AADT = Annual Average Daily Traffic (average daily traffic for a seven-day week).
[5]See the 1998 HPMS System Length and Daily Vehicle Travel summaries submitted to the Federal Highway Administration by the Arizona Department of Transportation on October 7, 1999.
[6]Divide by 0.91 to convert AADT to AWDT for comparison with transportation model output. This factor is based on continuous Automated Traffic Recorder (ATR) data for the Phoenix metropolitan area.
[7]The HPMS donut area is the area inside the PM-10 nonattainment area boundary, but outside the urbanized area boundary, as defined by the 1990 Census.

DERIVATION OF HPMS RECONCILIATION FACTORS (CONTINUED)

URBANIZED AREA #33

1998 HPMS VMT (By Functional System)	Column A
Freeways (Interstate + Other Freeways)	16,486,814
Arterials (Other Principal Arterial + Minor Arterial)	29,990,110
Collector	5,603,297
Local	5,668,132
TOTAL	57,748,353

1998 Transportation Model VMT (By Facility Type)	Column B
Freeways (#1 + #7 + #8 + #10)	15,434,806
Arterials (#2 + #4 + #6 + #9)	34,576,177
Collectors (#3)	1,996,676
Locals (#5)	6,059,922
TOTAL	58,067,581

HPMS Factors (By Facility Type)	Urbanized Area[8]
Freeways (#1 + #7 +#8 + #10)	1.0682[9]
Arterials (#2 + #4 + #6 + #9)	0.8674[9]
Collectors (#3)	1.0000[10]
Locals (#5)	1.5305[10]

[8] The HPMS Factors for Urbanized Area #33 are applied to the VMT on each transportation model link located in the urbanized area, based on the facility type of the link.

[9] Obtained by dividing the 1998 HPMS VMT in Column A by the corresponding 1998 Model VMT in Column B for freeways and arterials.

[10] Although the factor derived by dividing collector VMT in Column A by Column B would be 2.8063, applying this factor to VMT on collector links from the transportation model would unrealistically overload the traffic volumes on the small number of collectors that are actually coded in the highway networks. The transportation model assumes that the remaining collector travel is included in the local (centroid) VMT. Therefore, the collector VMT on the highway network is left unfactored, and the additional HPMS collector VMT is added to the modeled local (centroid) VMT. The local factor is derived by summing HPMS collector and local VMT in Column A, subtracting the collector VMT in Column B, and dividing by the local VMT in Column B.

DERIVATION OF HPMS RECONCILIATION FACTORS (CONTINUED)

DONUT AREA #33

1998 HPMS VMT (By Functional System)	Column C
Principal Arterials	2,558,242
Minor Arterials and Major Collectors	2,459,341
SUBTOTAL	5,017,583
Minor Collectors and Locals	456,044
TOTAL	5,473,627

1998 Model VMT (By Facility Type)	Column D1	Column D2[11]	Column D3
Freeways (#1 + #7 + #8 + #10)	2,196,436	2,346,141	1,664,253[12]
Arterials (#2 + #4 + #6 + #9)	4,958,014	4,300,400	3,050,521[12]
Collectors (#3)	426,879	426,879	302,810[12]
SUBTOTAL	7,581,329	7,073,420	5,017,584
Locals (#5)	765,899		456,044[13]
TOTAL	8,347,228		5,473,628

HPMS Factors (By Facility Type)	Donut Area[14]
Freeways (#1 + #7 + #8 + #10)	0.7577
Arterials (#2 + #4 + #6 + #9)	0.6153
Collectors (#3)	0.7094
Locals (#5)	0.5954

[11]Since more than 90% of the VMT in the PM-10 nonattainment area occurs in the urbanized area, the methodology used to derive factors for the urbanized area is also used to reconcile transportation model VMT by facility type with HPMS VMT by functional system in the donut area. For freeways and arterials, Column D2 is derived by dividing Column A by Column B and multiplying by Column D1. For collectors, the urbanized area factor of 1.0 is applied to Column D1 to obtain Column D2.
[12]Obtained by multiplying Column D2 by the SUBTOTAL in Column C divided by the SUBTOTAL in Column D2. This normalizes the model VMT for freeways, arterials and collectors to the HPMS VMT for principal arterials, minor arterials and major collectors. It is assumed that all arterials and major collectors in the donut area are included in the highway network. This is a reasonable assumption, because only collectors carrying the highest levels of traffic are coded in the highway network in the donut area.
[13]From Column C for minor collectors and locals. It is assumed that the VMT for minor collectors and locals is included in the local (centroid) VMT from the transportation model.
[14]The HPMS Factors for Donut Area #33 are derived by dividing Column D3 by Column D1. These are applied to the VMT on each transportation model link located in the donut area, based on the facility type of the link.

1998 HPMS SYSTEM LENGTH AND DAILY VEHICLE TRAVEL SUMMARIES

SUBMITTED TO FHWA BY ADOT ON OCTOBER 7, 1999

HPMS 1998

SYSTEM LENGTH AND DAILY VEHICLE TRAVEL

VERSION 2.50

1/20/2000

INDIVIDUAL URBANIZED AREAS

URBANIZED AREAS

Arizona

Page 1

Shaded cells are reserved for titles and computer software generated values. Enter data in the unshaded cells only.

URBANIZED AREA CODE	NONAT-TAINMENT AREA CODE 2/	POPULATION (1,000)	NET LAND AREA	DATA TYPE	FUNCTIONAL SYSTEM						
					PRINCIPAL ARTERIAL						
					INTERSTATE	OTHER FREEWAYS & EXPRESSWAYS	OTHER	MINOR ARTERIAL	COLLECTOR	LOCAL	TOTAL
33	33	2,482	1,054	LENGTH 1/	53	86	623	605	662	7,527	9,556
				TRAVEL (1,000) 1/	7,526	7,477	18,062	9,229	5,099	5,158	52,551
				OCCUPANCY 3/	1.3	1.3	1.3	1.3	1.3	1.3	
73	73	662	312	LENGTH 1/	19	14	174	308	195	1,472	2,181
				TRAVEL (1,000) 1/	1,462	451	5,188	3,945	703	962	12,711
				OCCUPANCY 3/	1.2	1.2	1.3	1.3	1.3	1.3	
287	0	89	34	LENGTH 1/	4	0	22	24	20	198	268
				TRAVEL (1,000) 1/	70	0	461	286	98	122	1,037
				OCCUPANCY 3/	1.6	0.0	1.6	1.4	1.3	1.3	
420	0	60	73	LENGTH 1/	17	0	13	26	50	168	274
				TRAVEL (1,000) 1/	343	0	260	144	158	107	1,012
				OCCUPANCY 3/	1.2	0.0	1.2	1.2	1.2	1.2	

1 /English units for length and travel are miles and vehicle-miles (in thousands), respectively.

2/ The National Ambient Air Quality Standards Nonattainment Area Code is the same as the Urbanized Area Code of the primary urbanized area contained in the nonattainment area. When the Urbanized Area is not in a nonattainment area, code zero.

3/ Average vehicle occupancy is reported to the nearest tenth of a person.

Report is in English Units.

HPMS 1998 1/20/2000 **Arizona**

SYSTEM LENGTH AND DAILY VEHICLE TRAVEL

DONUT AREA DATA FOR INDIVIDUAL NAAQS NONATTAINMENT AREAS

VERSION 2.50
DONUT AREAS
Page 1

Shaded cells are reserved for titles and computer software generated values. Enter data in the unshaded cells only.

NONAT-TAINMENT AREA CODE 2/	POPULATION (1,000)	NET LAND AREA	DATA TYPE	RURAL AND SMALL URBAN FUNCTIONAL SYSTEMS COMBINED			
				PRINCIPAL ARTERIAL	MINOR ARTERIAL AND (MAJOR) COLLECTOR	MINOR COLLECTOR AND LOCAL	TOTAL
33	185	1,421	LENGTH 1/	124	643	1,307	2,074
			TRAVEL (1,000) 1/	2,328	2,238	415	4,981
73	94	640	LENGTH 1/	54	168	502	724
			TRAVEL (1,000) 1/	1,408	734	217	2,359

1 /English units for length and travel are miles and vehicle-miles (in thousands), respectively.
2/ The National Ambient Air Quality Standards Nonattainment Area Code is the same as the Urbanized Area Code of the primary urbanized area contained in the nonattainment area.
When the Urbanized Area is not in a nonattainment area, code zero.

ɔrt is in English Units.

APPENDIX IV

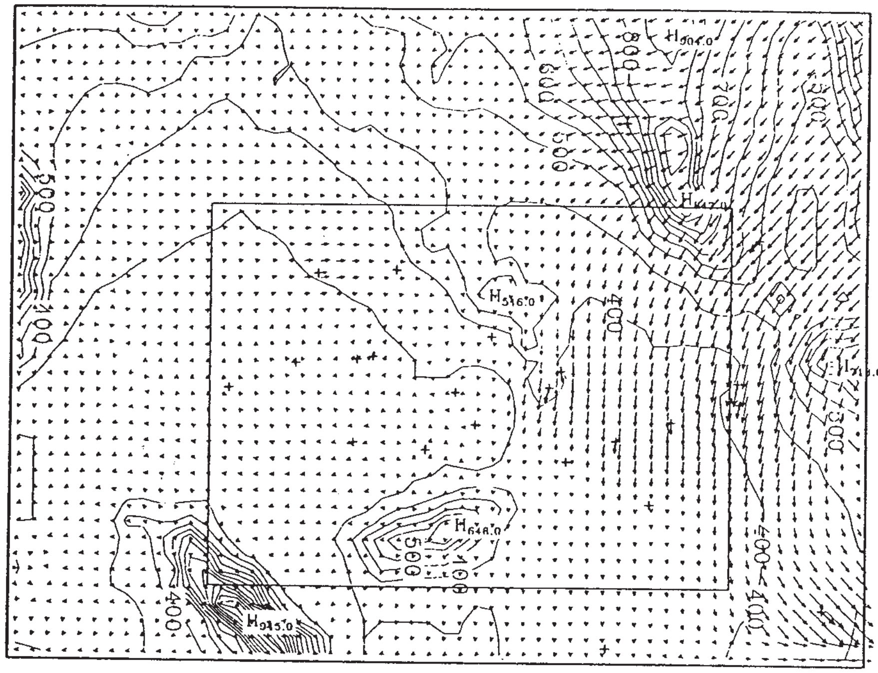
MODELING ANALYSES

Appendix IV-i

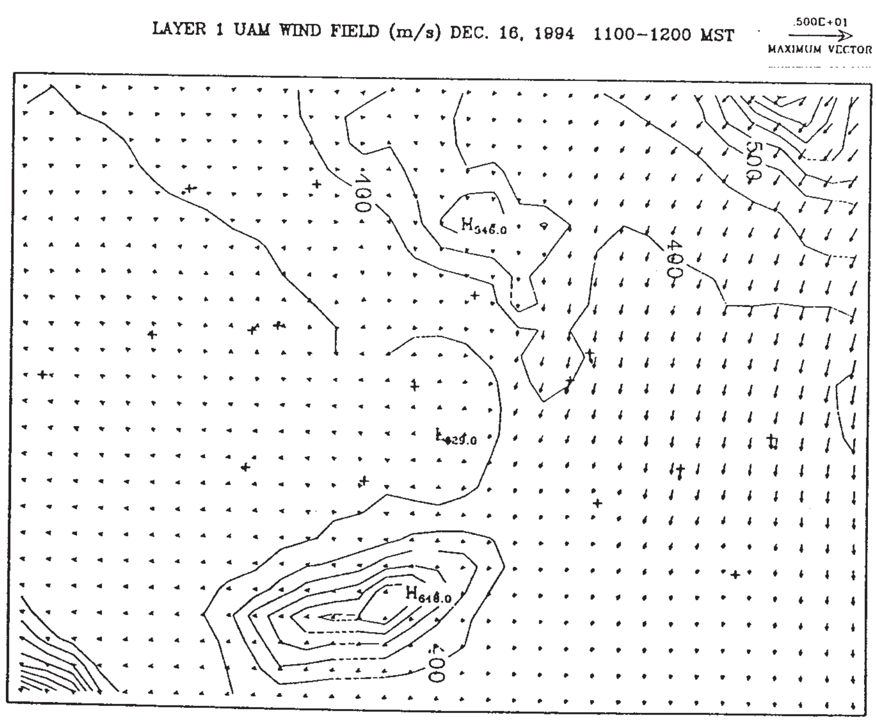
MODELED WIND FIELDS

The plots shown here are the simulated DWM and UAM winds overlaid with observed wind vectors extended from the plus signs indicating the locations of the monitoring sites. These hourly wind fields are from hour 1200 on December 16, 1994 to hour 1200 on December 17, 1994.

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 11 - 12 MST
MAG CO UAM AIRSHED IS INSET



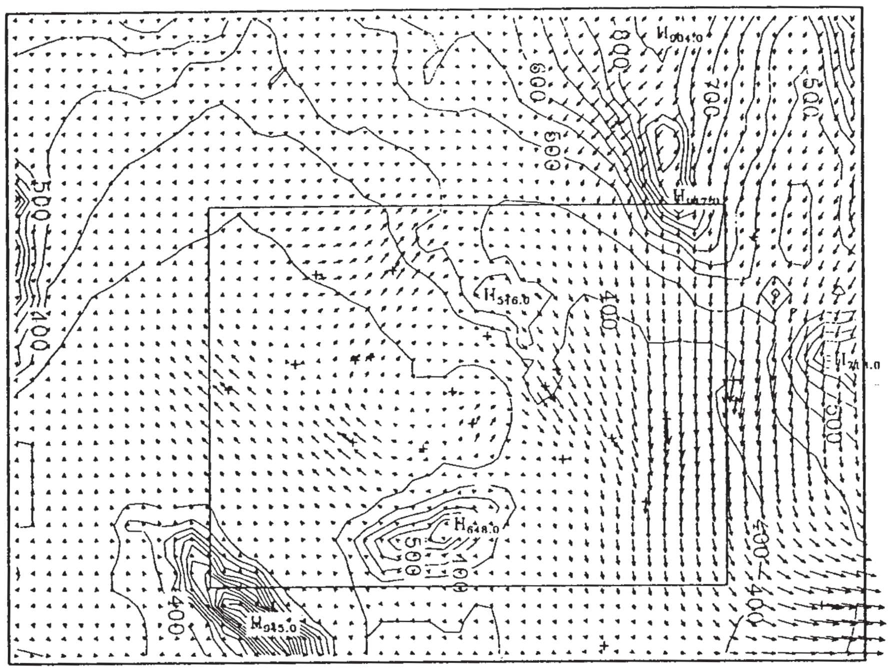
LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1100-1200 MST



DOMAIN MEAN WIND U = -.13 V = -.28 MPS = .40

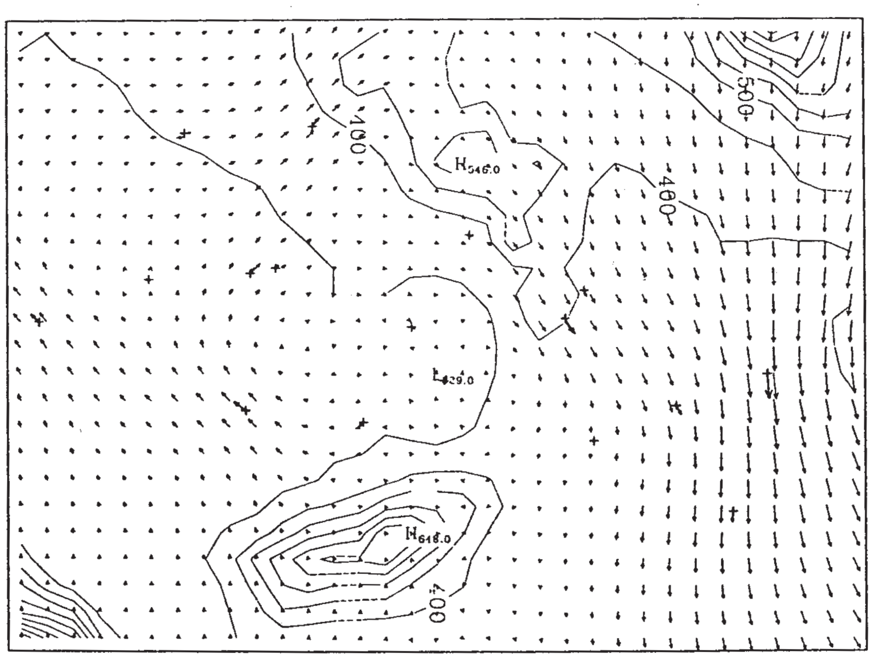
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 12 - 13 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1200-1300 MST

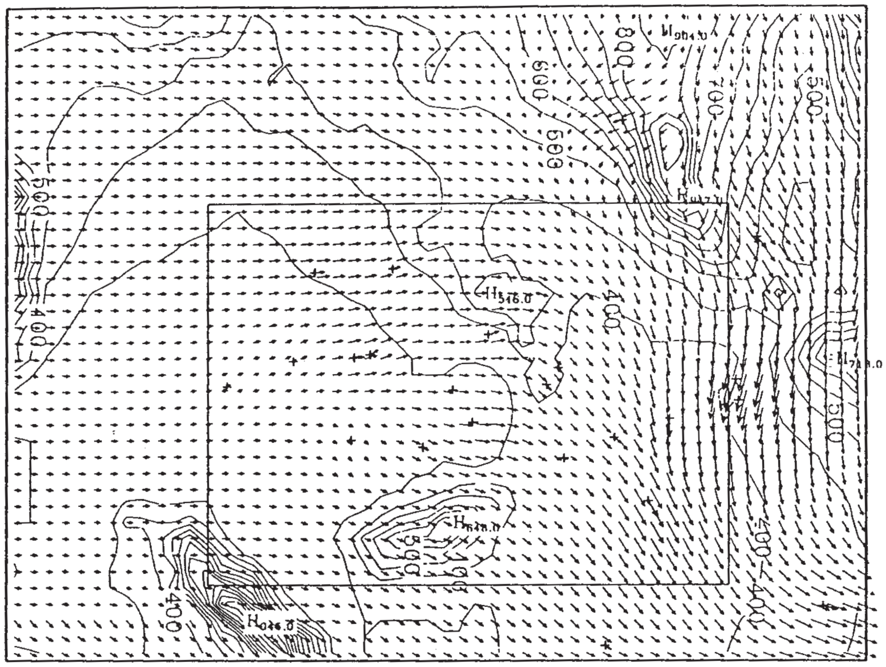
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = .09 V = -.25 MPS = .62

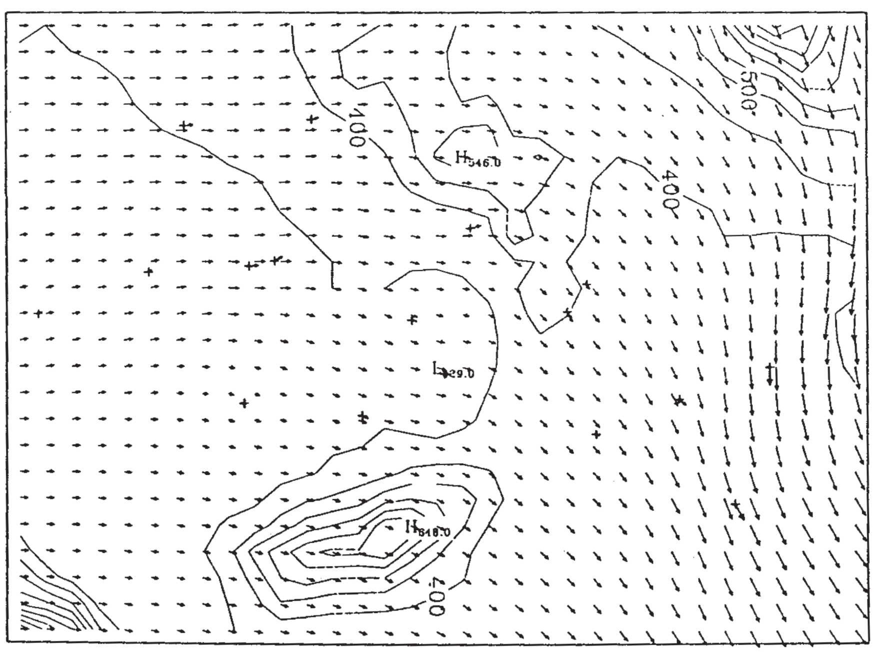
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 13 - 14 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1300-1400 MST

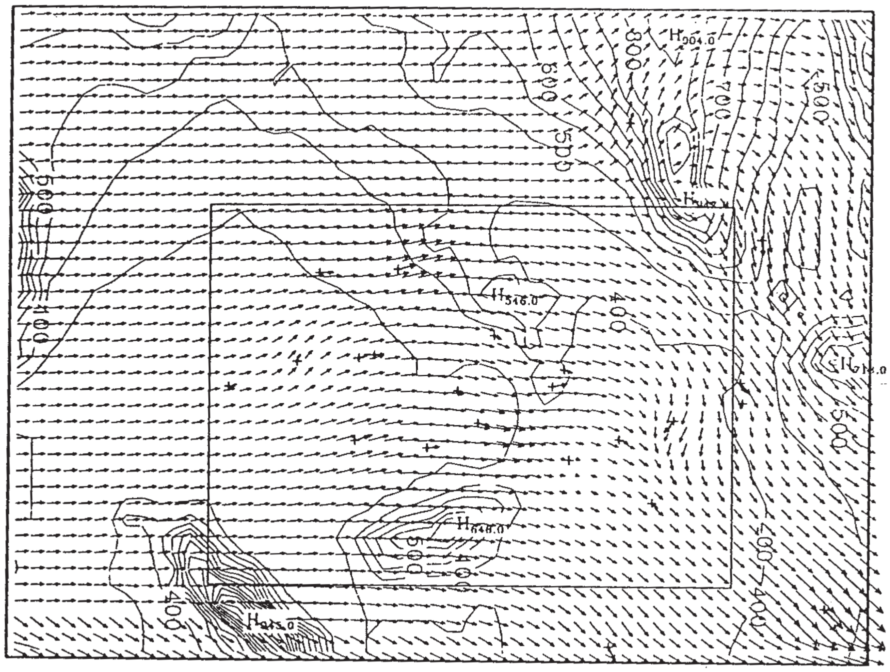
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = .60 V = -.45 MPS = .88

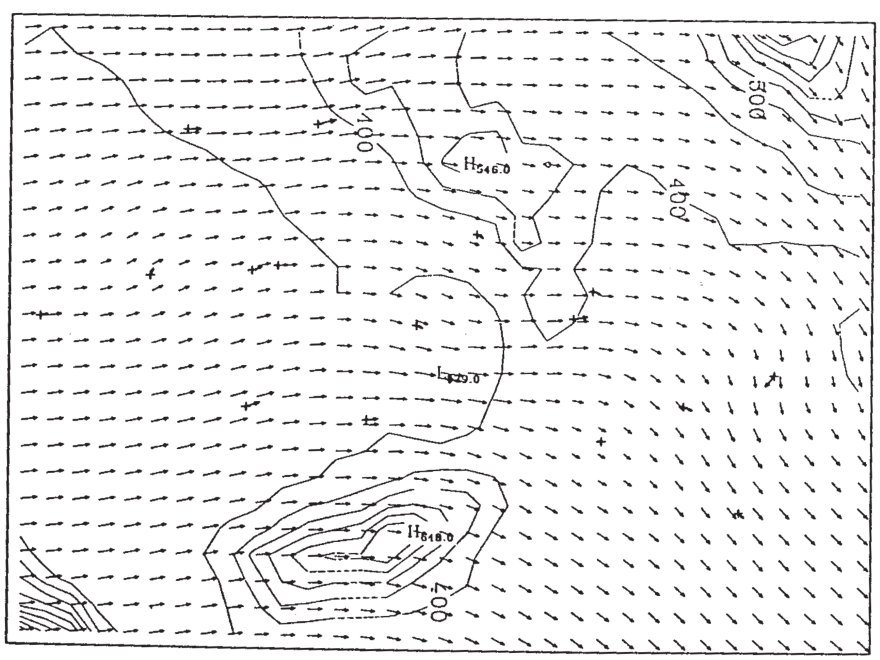
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 14 - 15 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1400–1500 MST

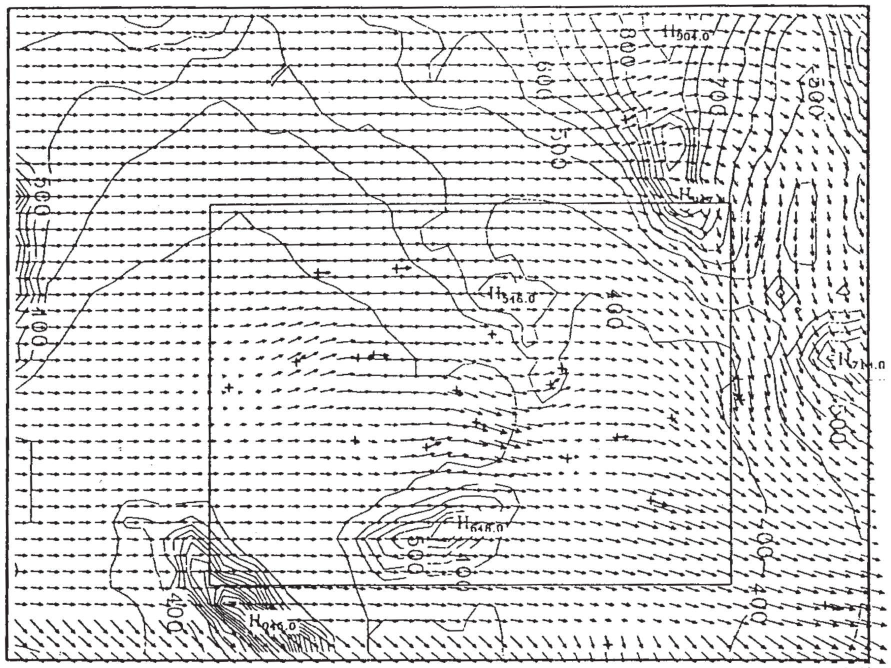
.500E+01
MAXIMUM VECTOR



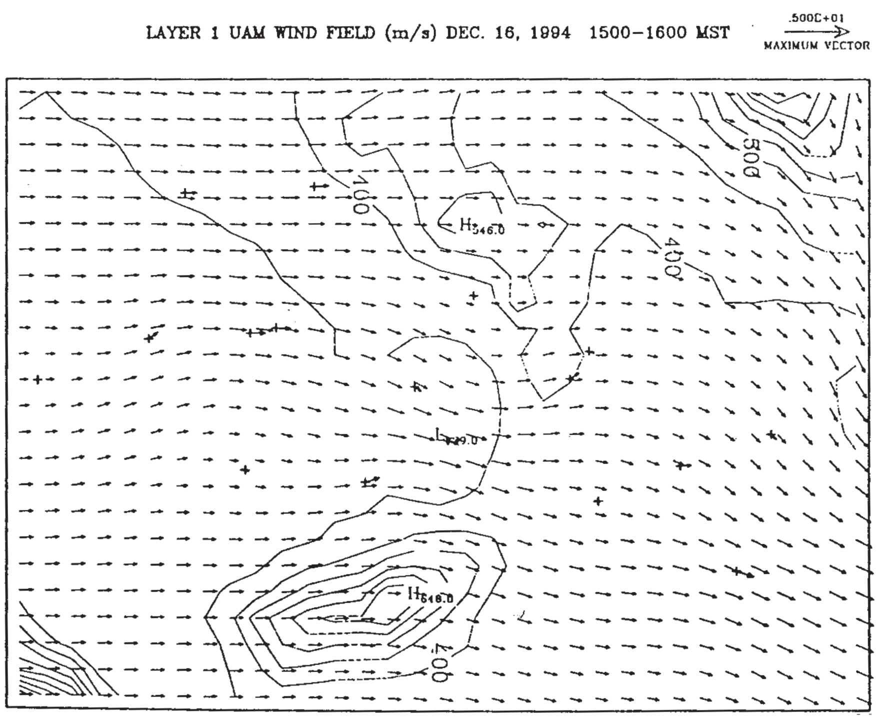
DOMAIN MEAN WIND U = 1.02 V = –.17 MPS = 1.13

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 15 – 16 MST
MAG CO UAM AIRSHED IS INSET



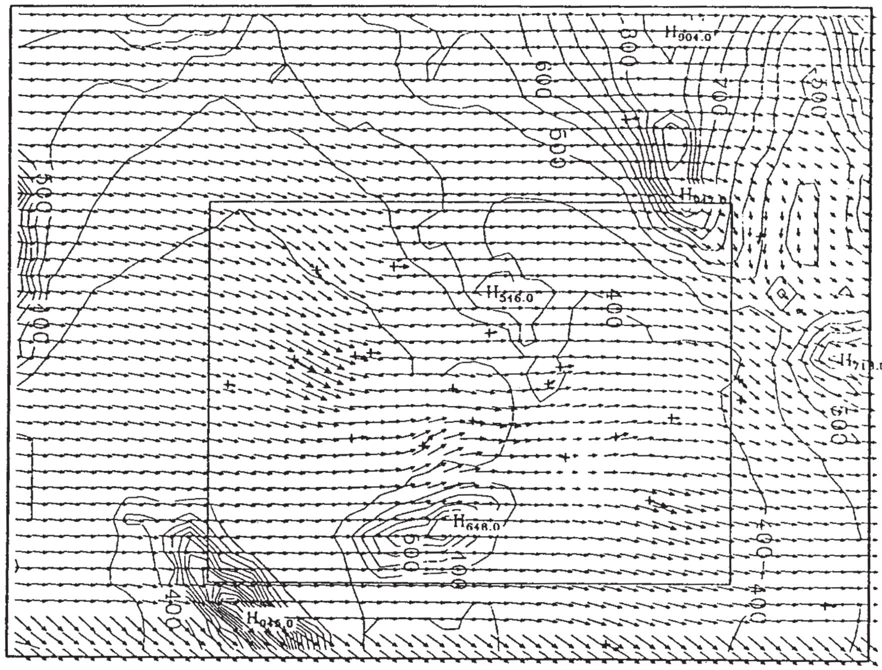
LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1500–1600 MST



DOMAIN MEAN WIND U = 1.03 V = –.19 MPS = 1.10

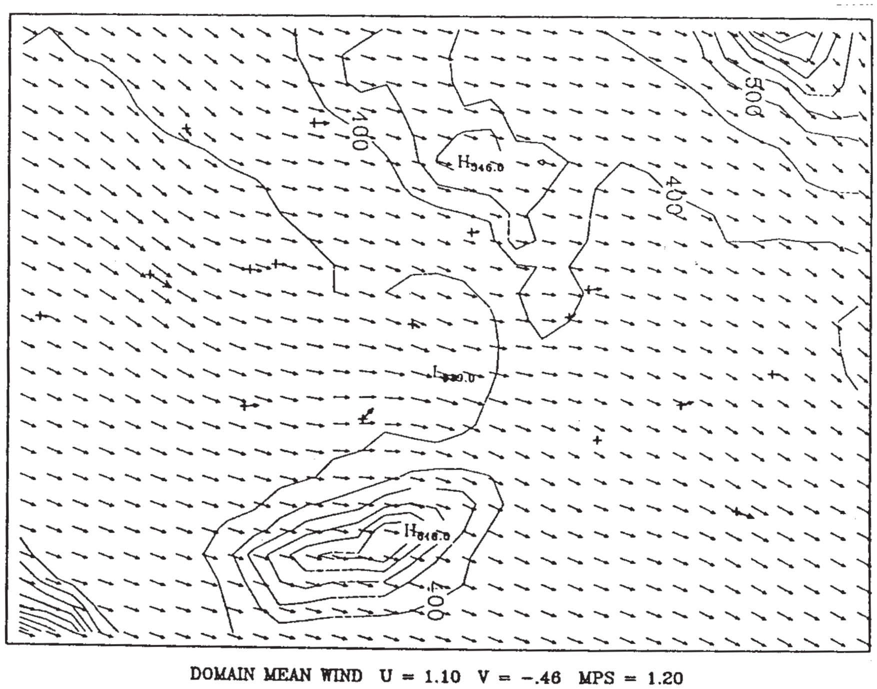
6 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 16 - 17 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1600-1700 MST

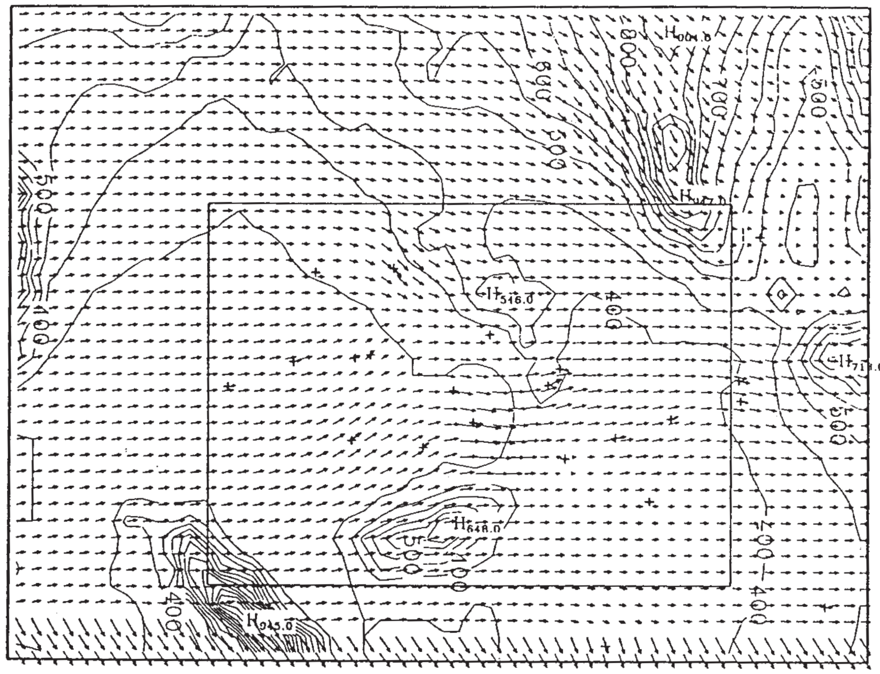
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = 1.10 V = -.46 MPS = 1.20

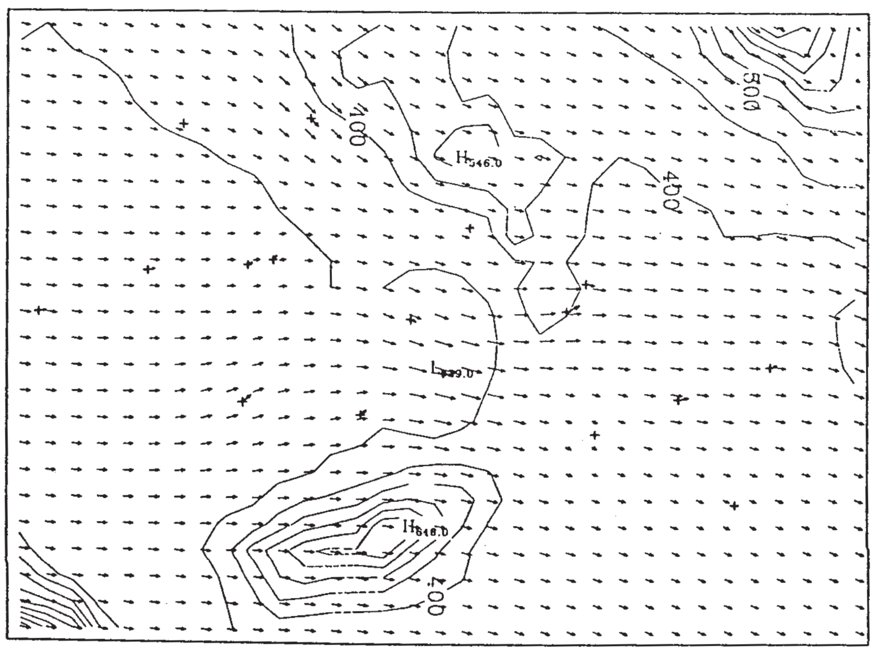
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 17 - 18 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1700-1800 MST

.500E+01
MAXIMUM VECTOR



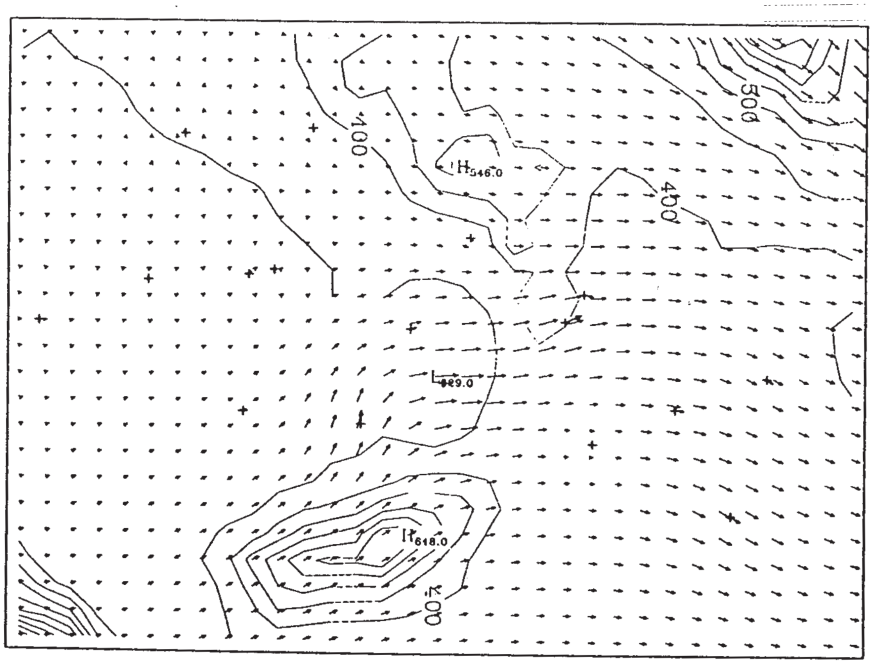
DOMAIN MEAN WIND U = .78 V = -.18 MPS = .82

6 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 18 – 19 MST
MAG CO UAM AIRSHED IS INSET

LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1800–1900 MST

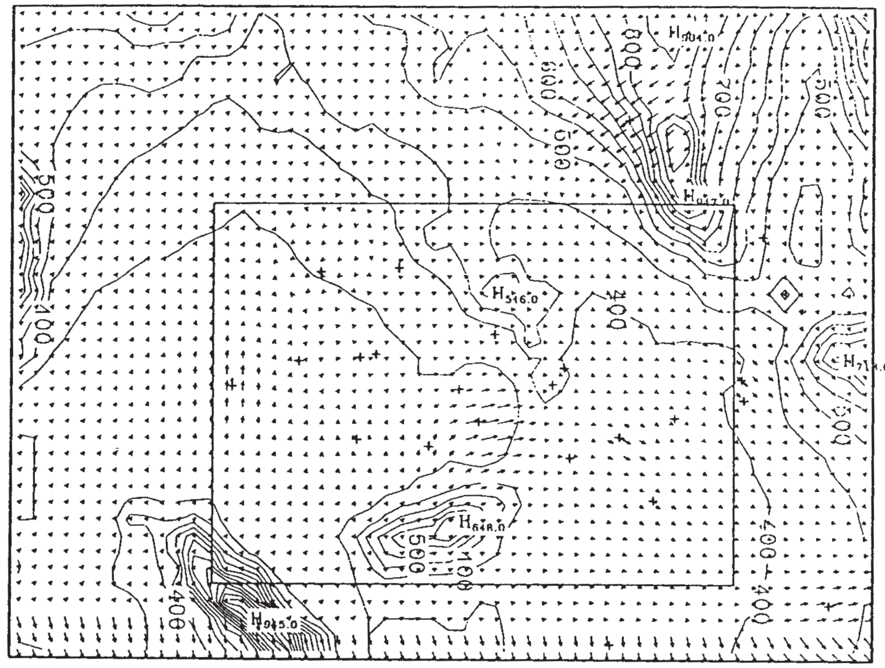
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = .58 V = .01 MPS = .64

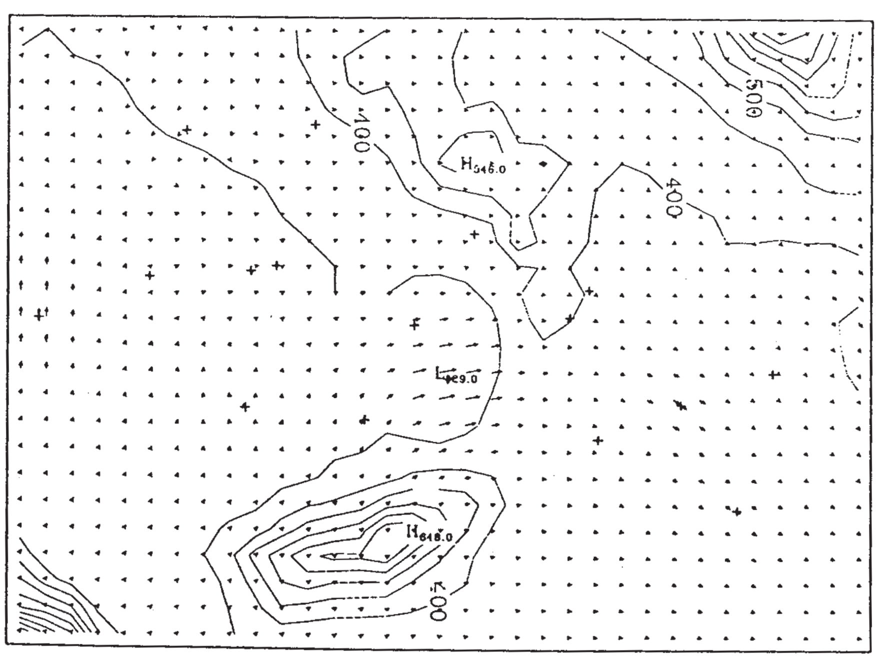
6 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 19 - 20 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 1900-2000 MST

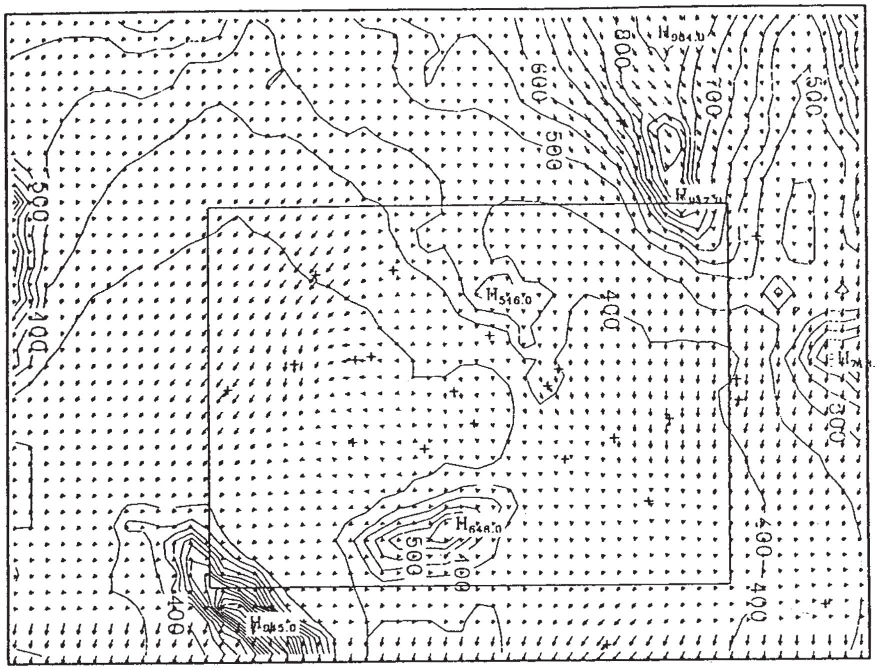
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = .19 V = .03 MPS = .26

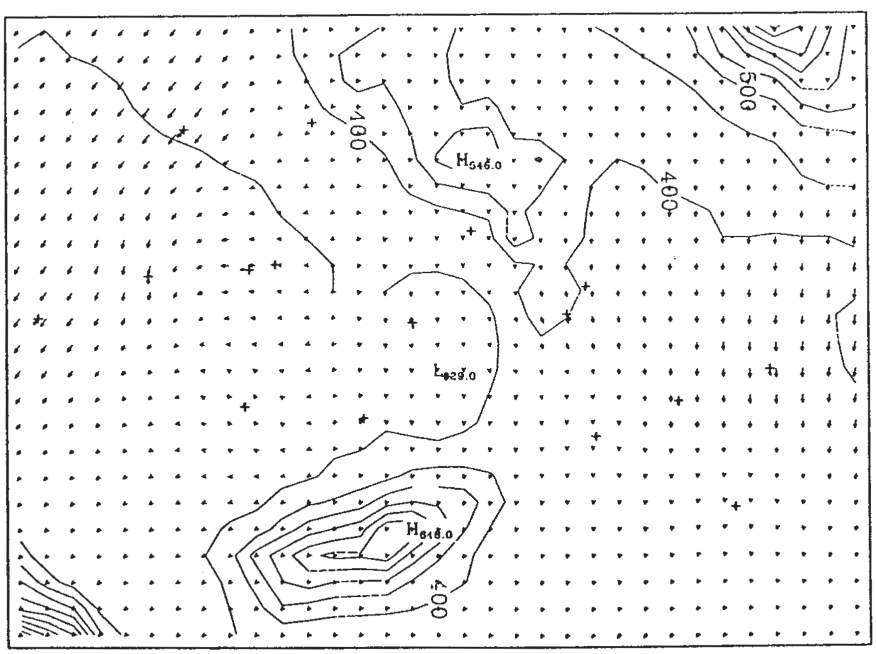
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 20 – 21 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 2000–2100 MST

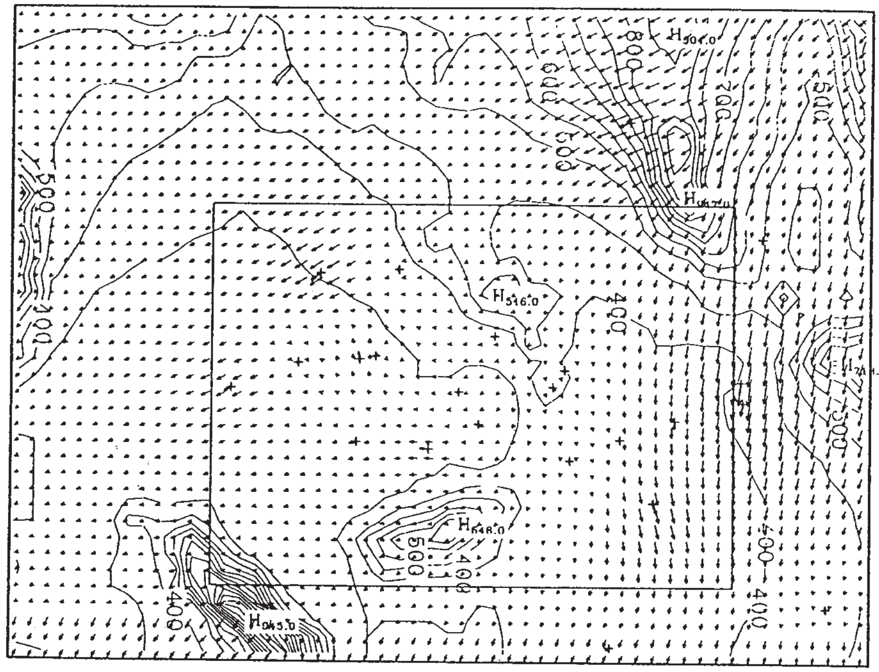
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = –.12 V = –.32 MPS = .38

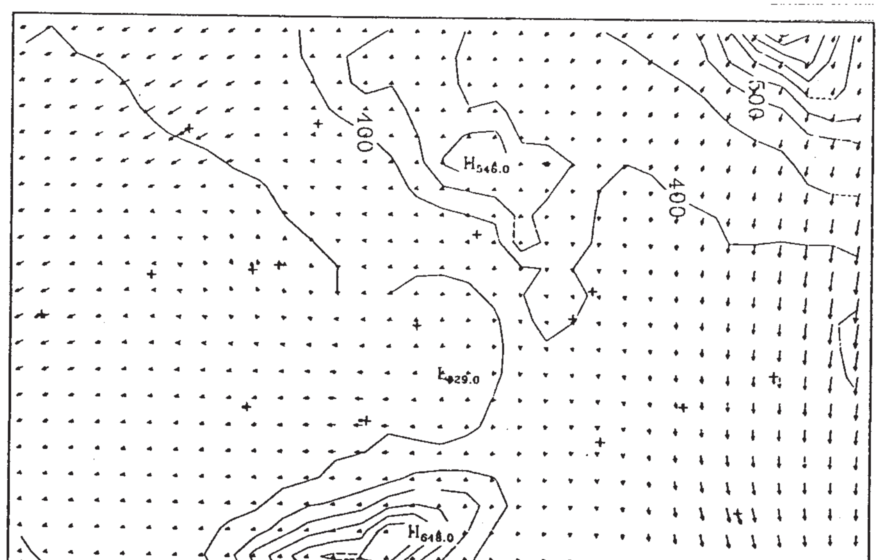
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 21 - 22 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 2100-2200 MST

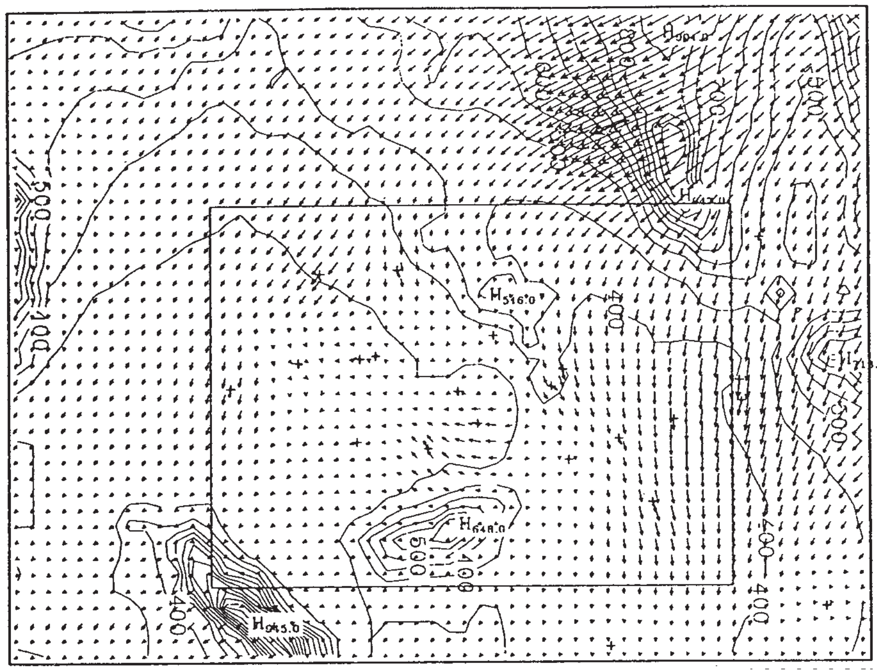
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = -.22 V = -.32 MPS = .47

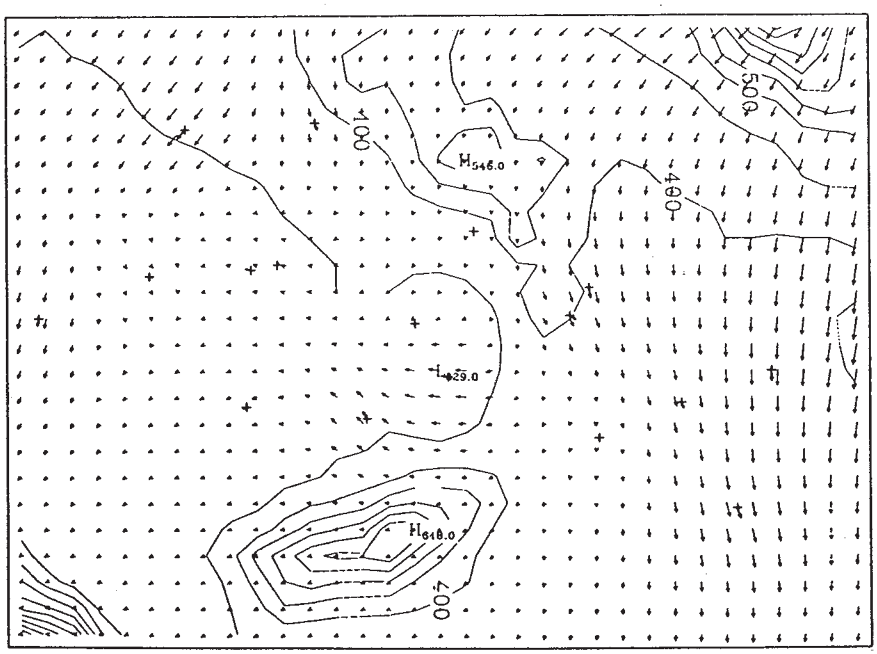
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 22 - 23 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 2200-2300 MST

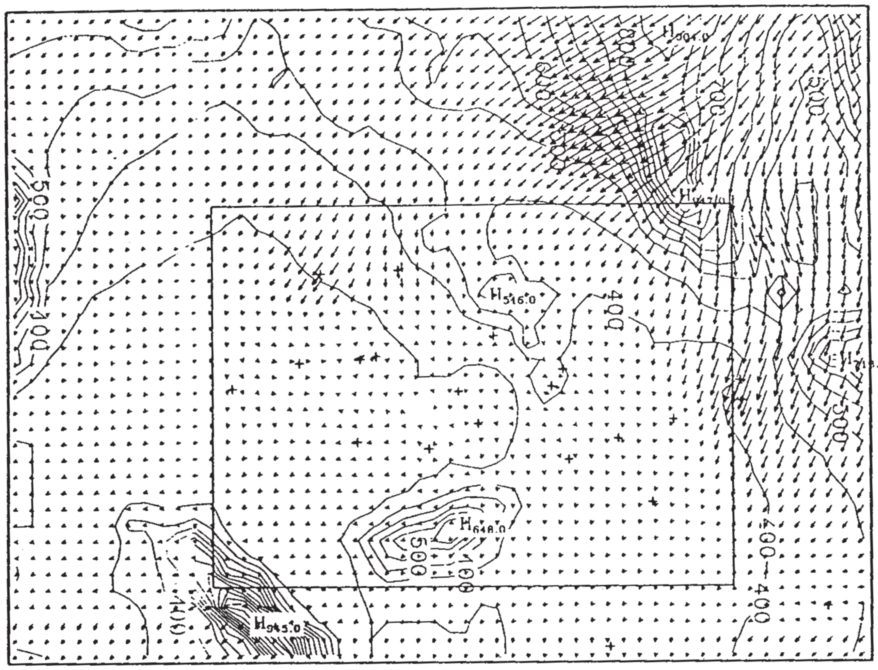
.500E+01
MAXIMUM VECTOR



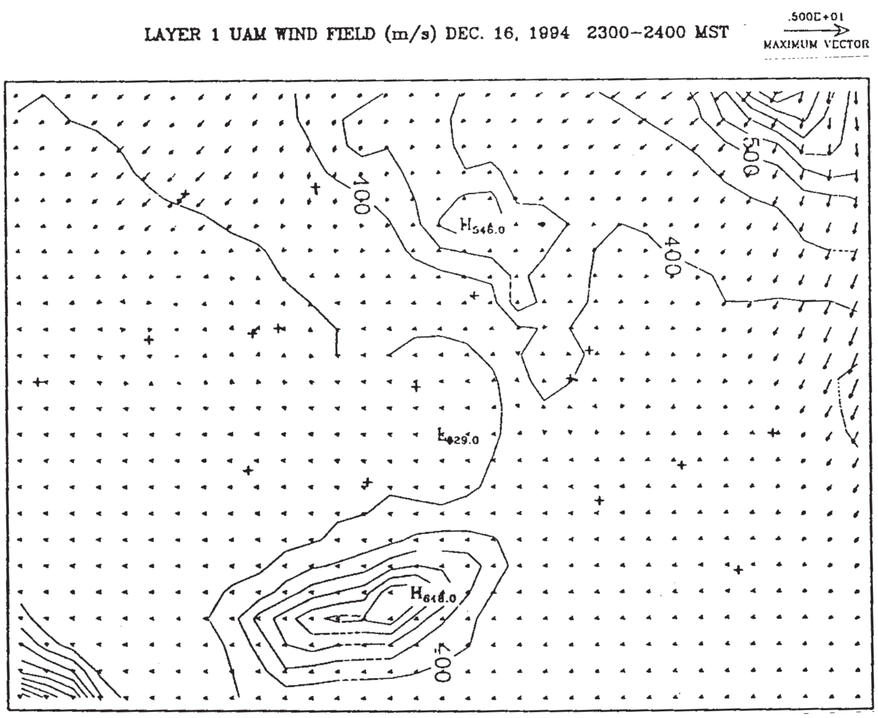
DOMAIN MEAN WIND U = -.21 V = -.47 MPS = .59

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 16, 1994 23 - 24 MST
MAG CO UAM AIRSHED IS INSET



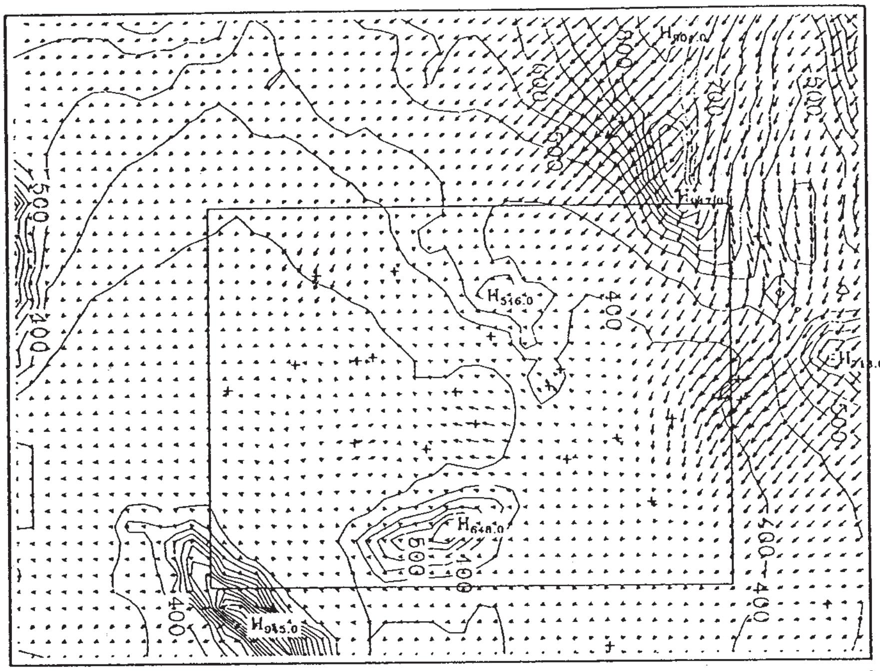
LAYER 1 UAM WIND FIELD (m/s) DEC. 16, 1994 2300-2400 MST



DOMAIN MEAN WIND U = -.23 V = -.18 MPS = .34

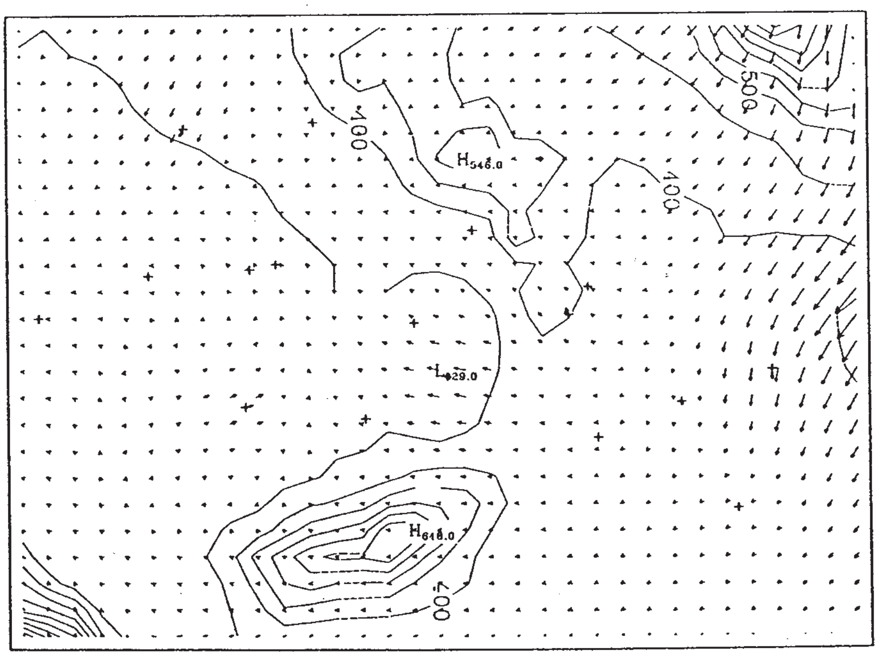
6 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994   0 – 1 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0000–0100 MST

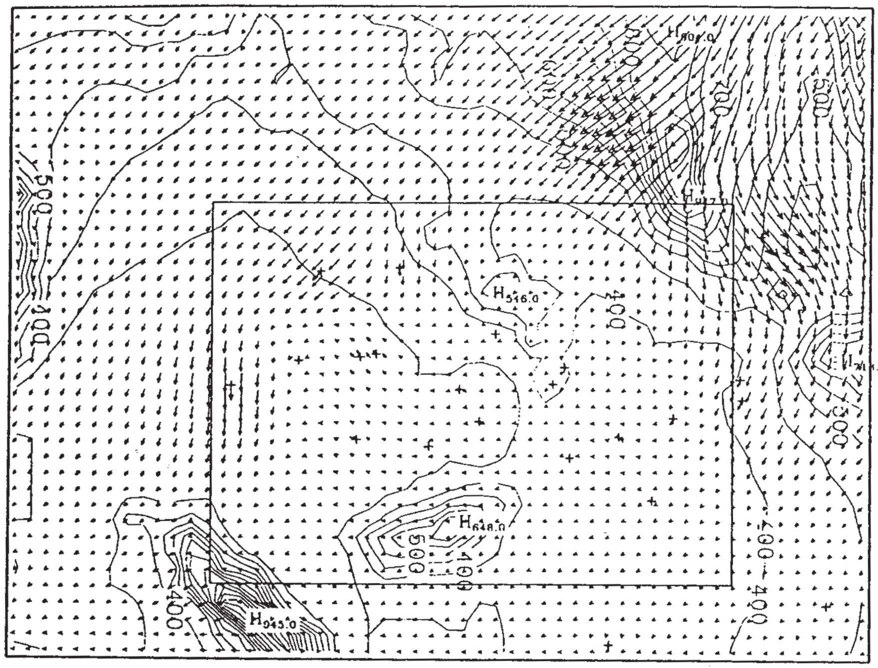
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = –.23 V = –.19 MPS = .40

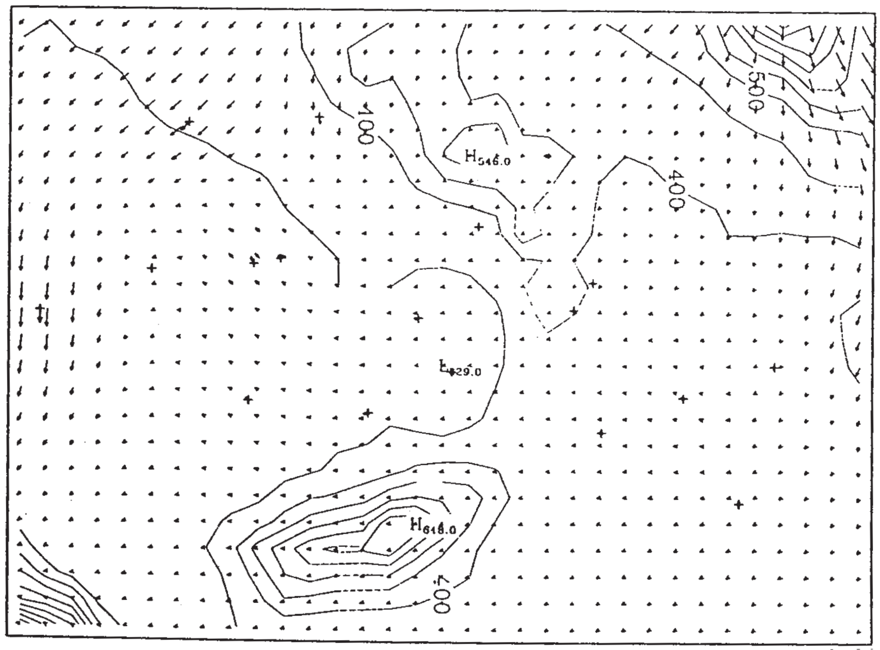
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 1 - 2 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0100–0200 MST

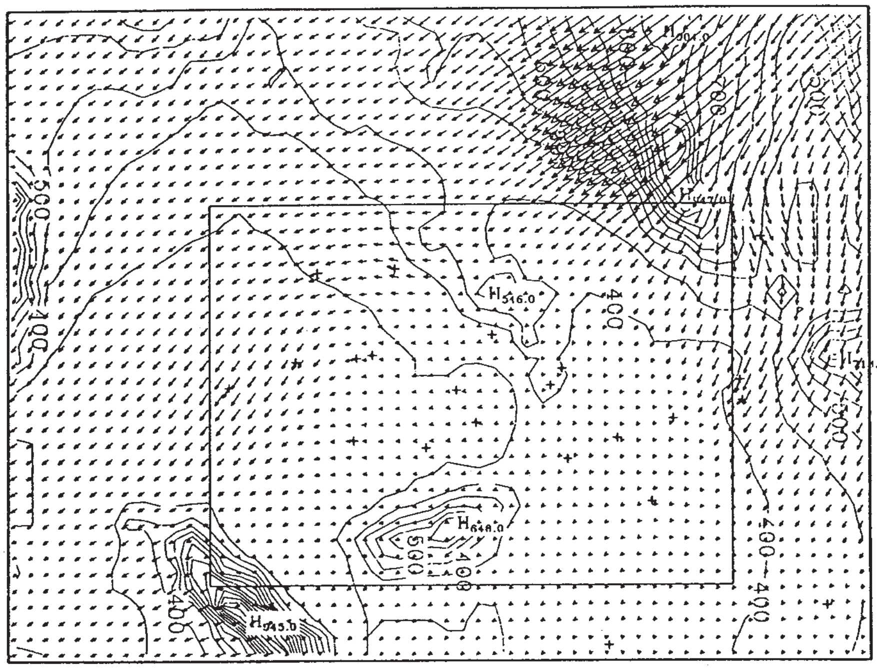
.500E+01 MAXIMUM VECTOR



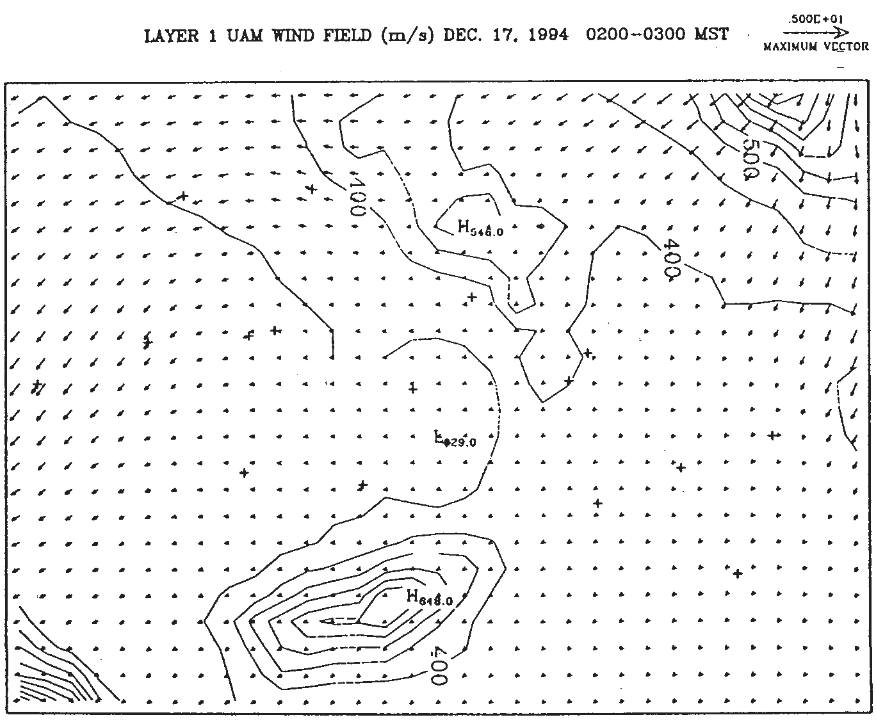
DOMAIN MEAN WIND U = -.21 V = -.24 MPS = .39

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 2 - 3 MST
MAG CO UAM AIRSHED IS INSET



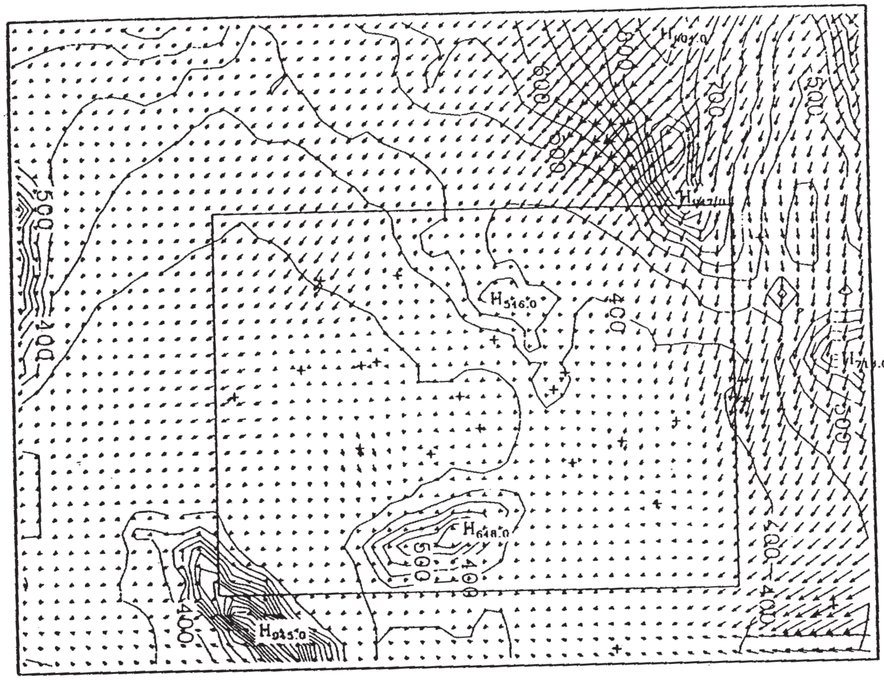
LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0200-0300 MST



DOMAIN MEAN WIND U = -.33 V = -.25 MPS = .45

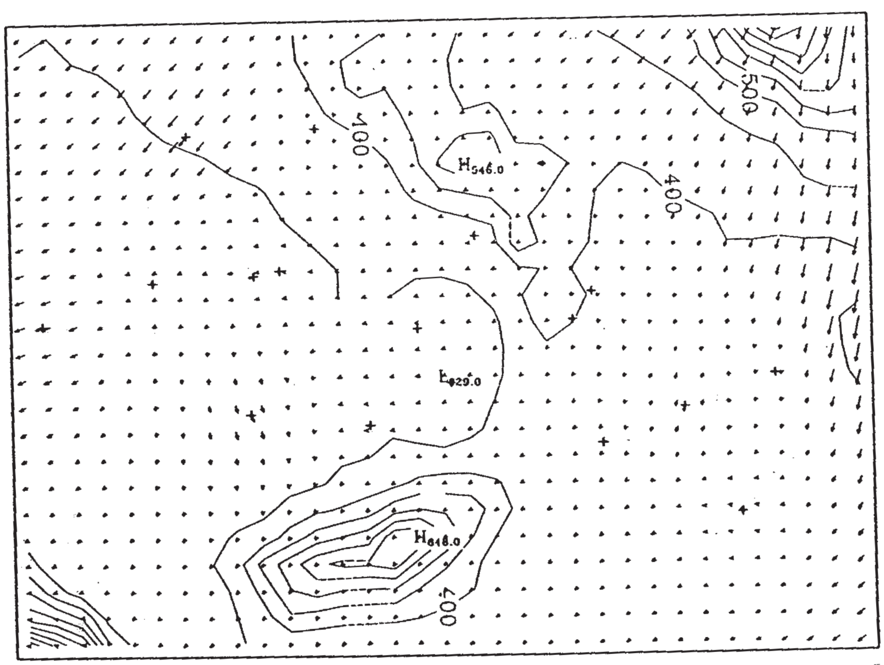
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 3 - 4 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0300-0400 MST

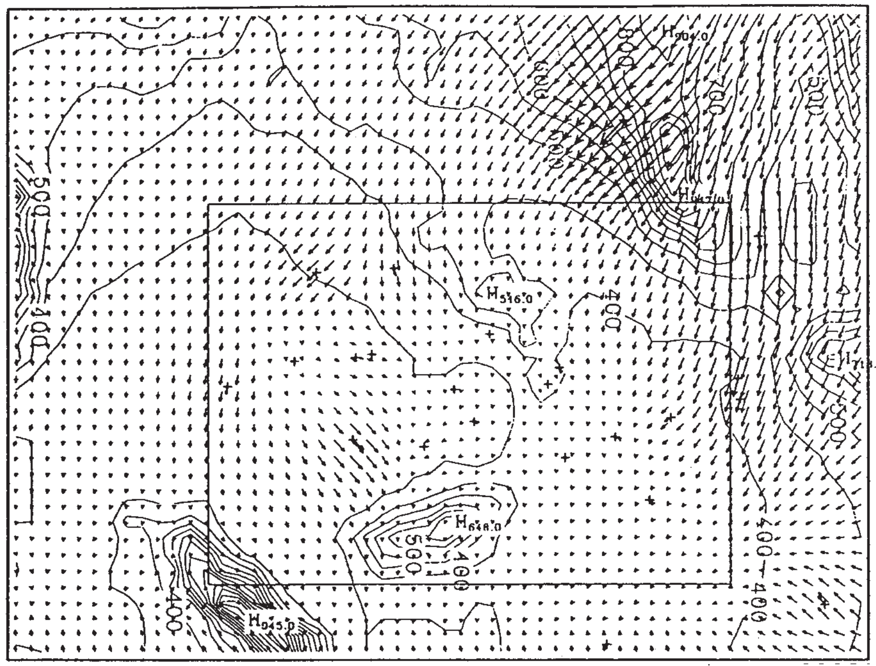
.500E+01
MAXIMUM VECTOR



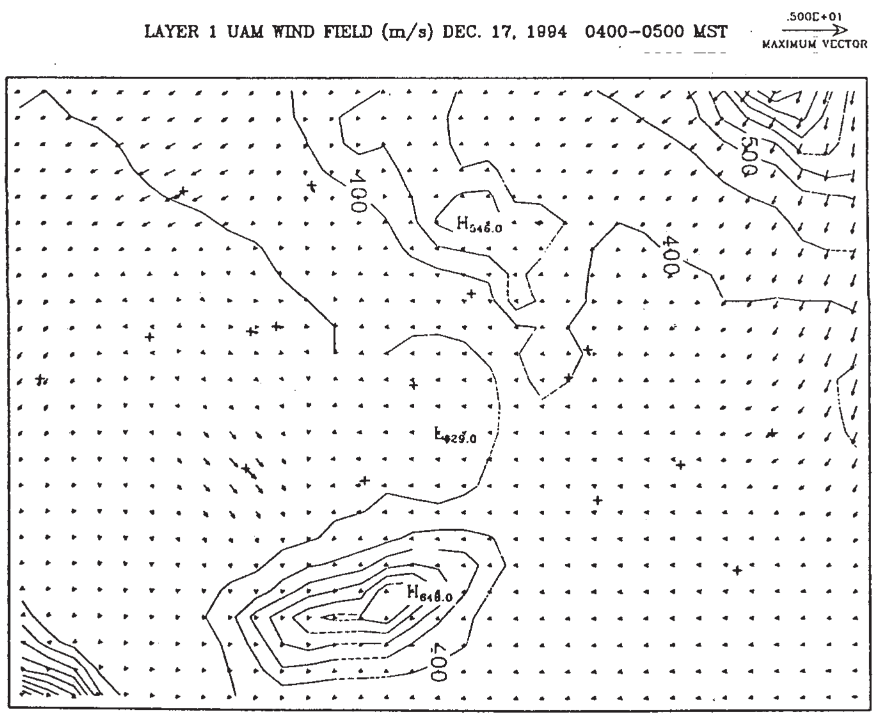
DOMAIN MEAN WIND U = -.24 V = -.32 MPS = .42

6 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 4 – 5 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0400–0500 MST

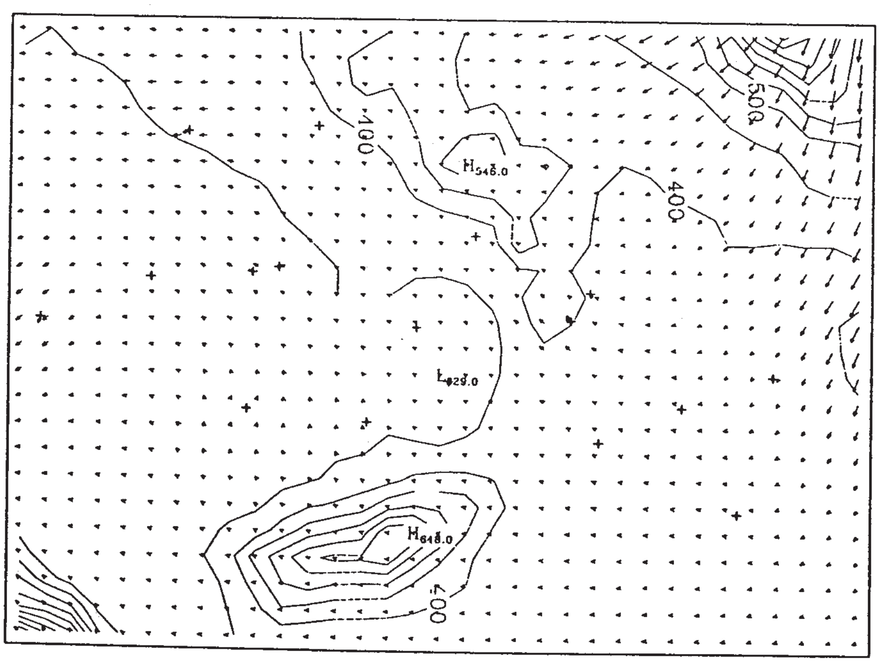


DOMAIN MEAN WIND U = –.22 V = –.22 MPS = .37

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 5 – 6 MST
MAG CO UAM AIRSHED IS INSET

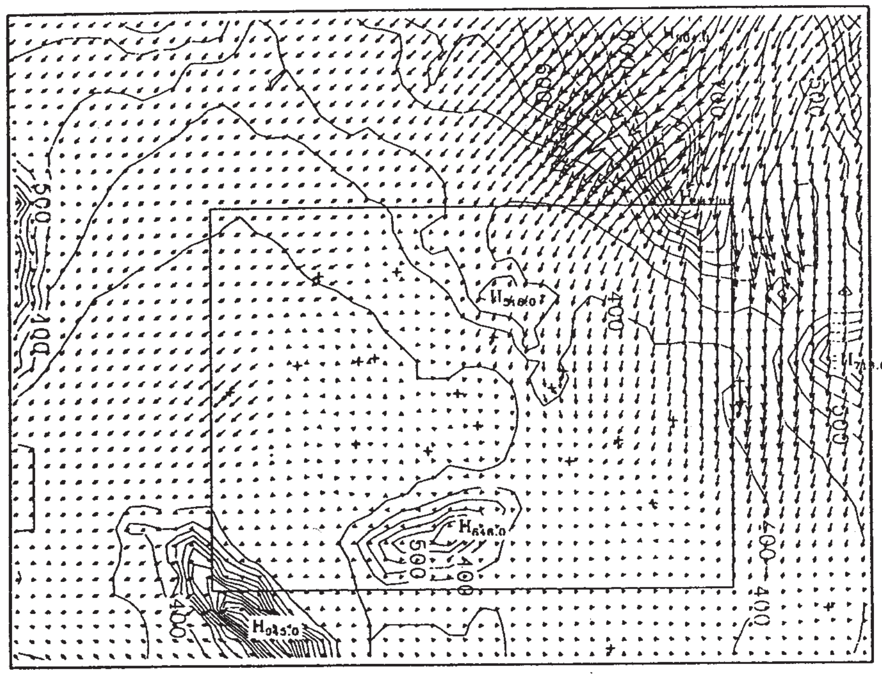
LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0500–0600 MST .500E+01 MAXIMUM VECTOR



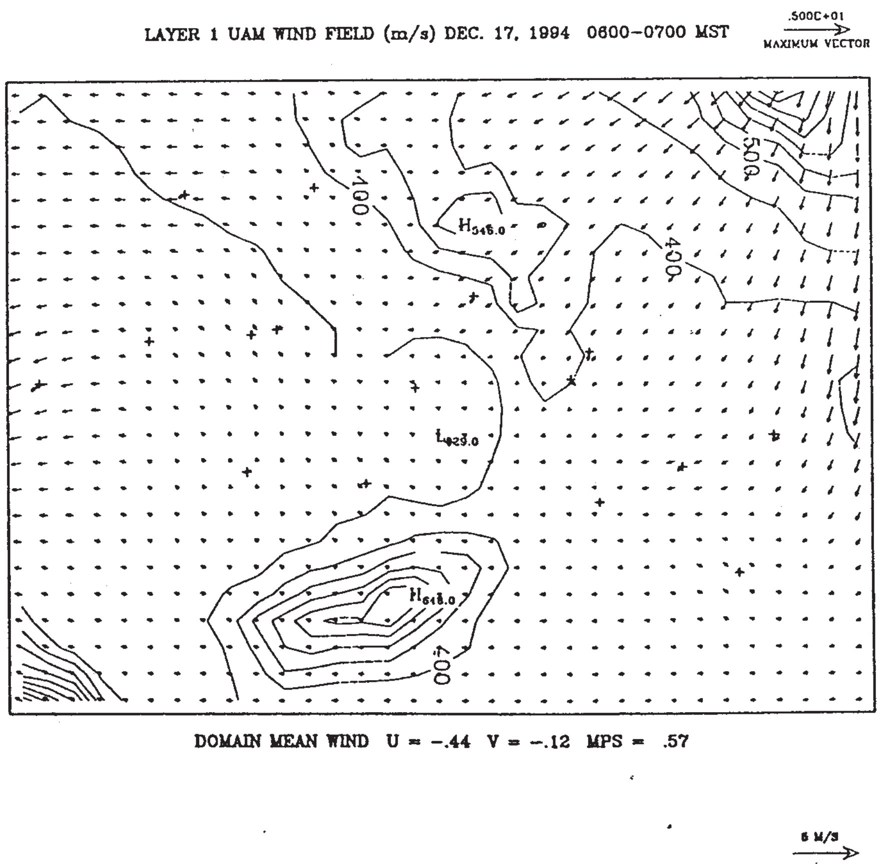
DOMAIN MEAN WIND U = –.31 V = –.07 MPS = .40

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 6 - 7 MST
MAG CO UAM AIRSHED IS INSET

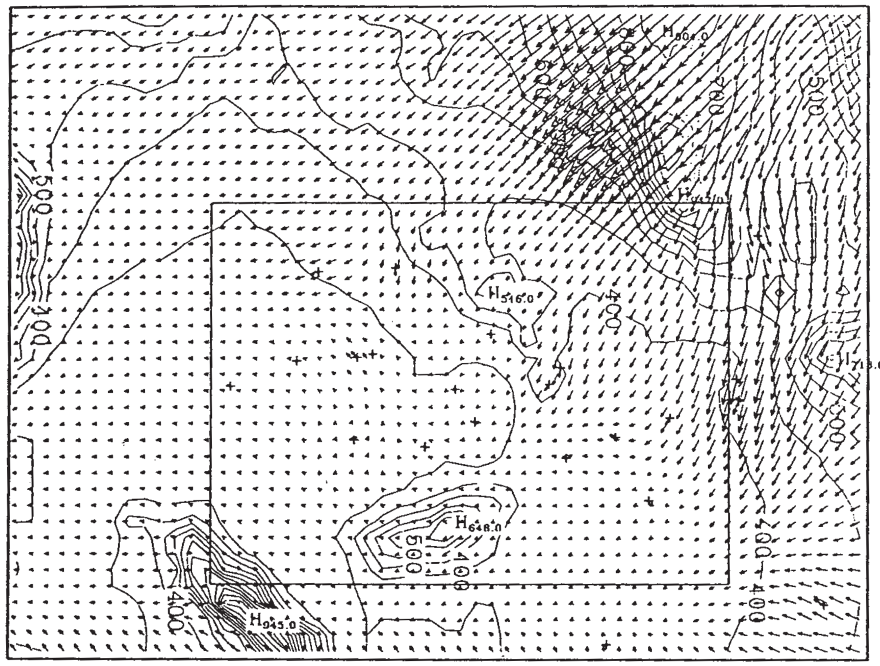


LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0600-0700 MST

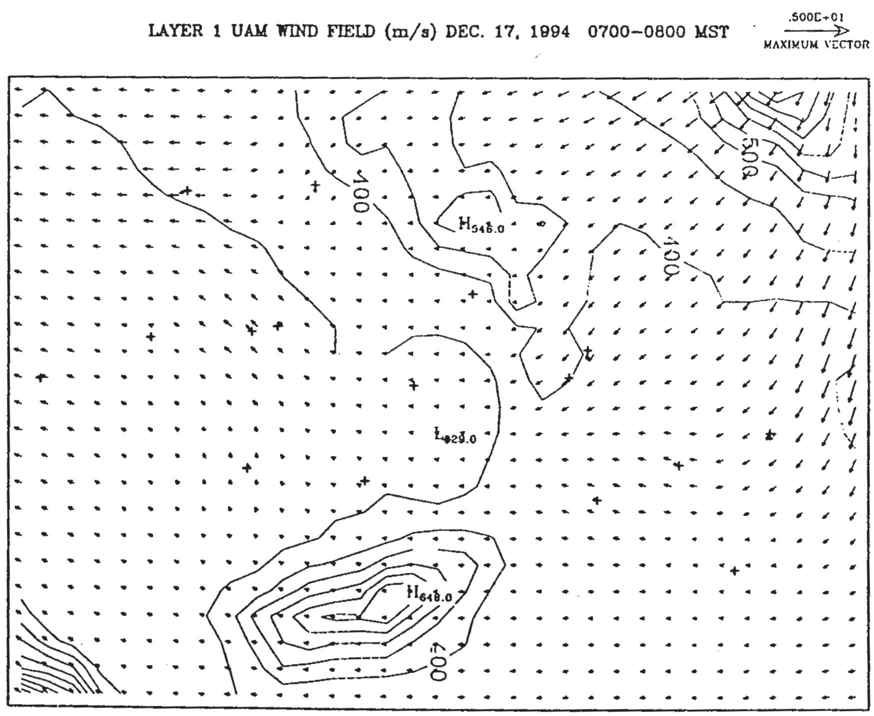


DOMAIN MEAN WIND U = -.44 V = -.12 MPS = .57

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 7 - 8 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0700-0800 MST

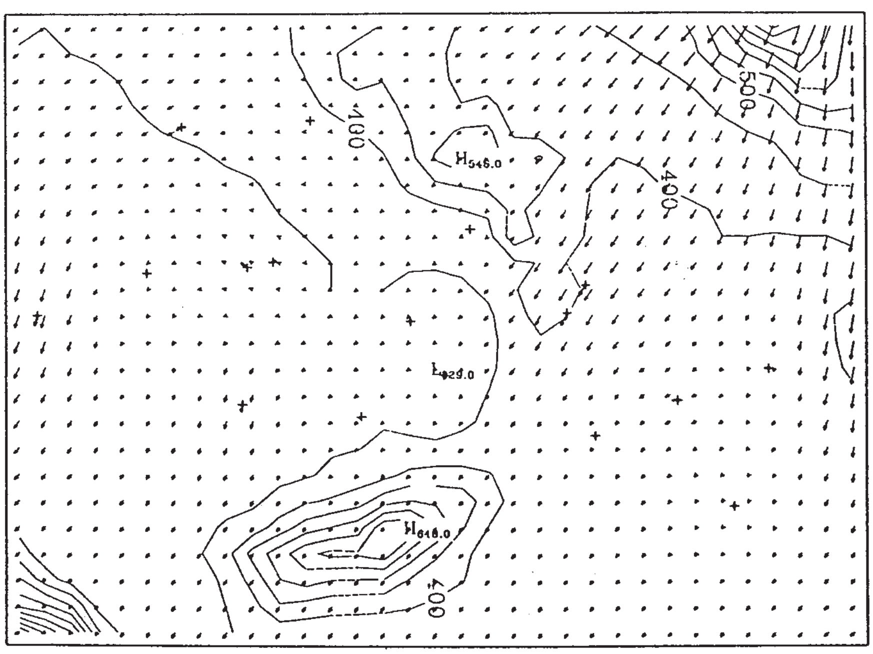


DOMAIN MEAN WIND U = -.46 V = -.09 MPS = .56

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 8 - 9 MST
MAG CO UAM AIRSHED IS INSET

LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0800-0900 MST

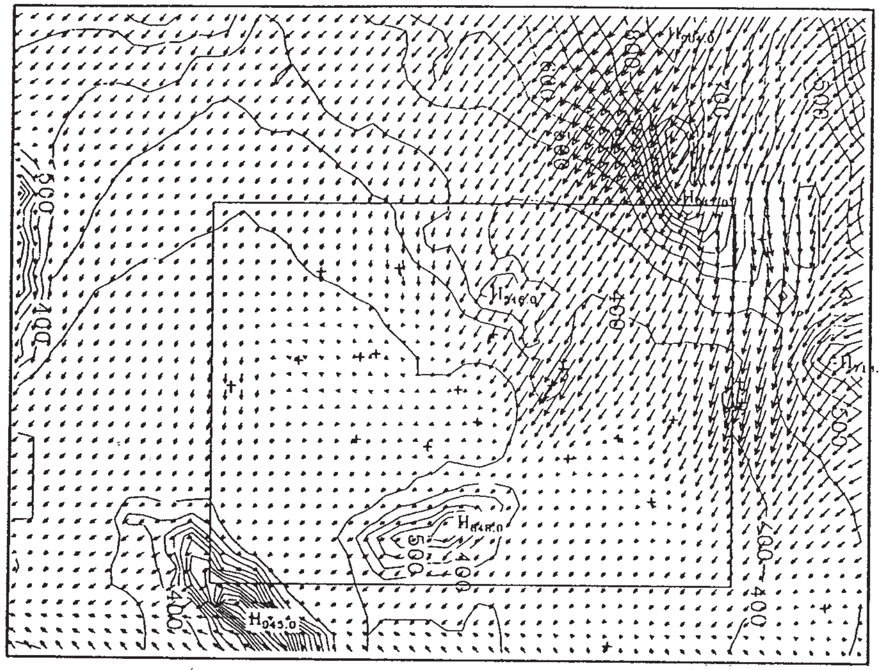
.500E+01
MAXIMUM VECTOR



DOMAIN MEAN WIND U = -.31 V = -.44 MPS = .56

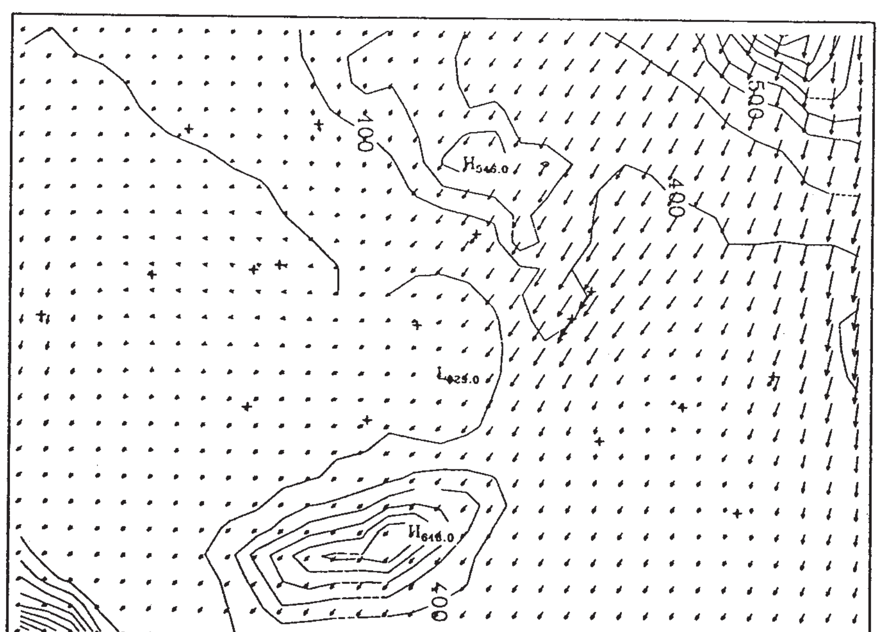
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 9 – 10 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 0900–1000 MST

.500E+01
MAXIMUM VECTOR

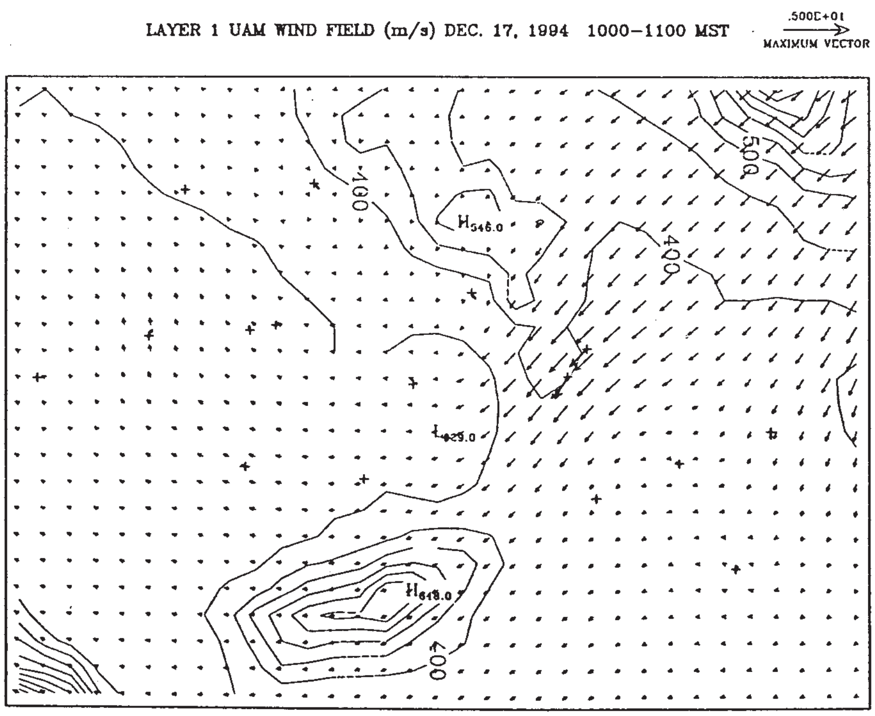


DOMAIN MEAN WIND U = –.38 V = –.64 MPS = .77

5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 10 - 11 MST
MAG CO UAM AIRSHED IS INSET

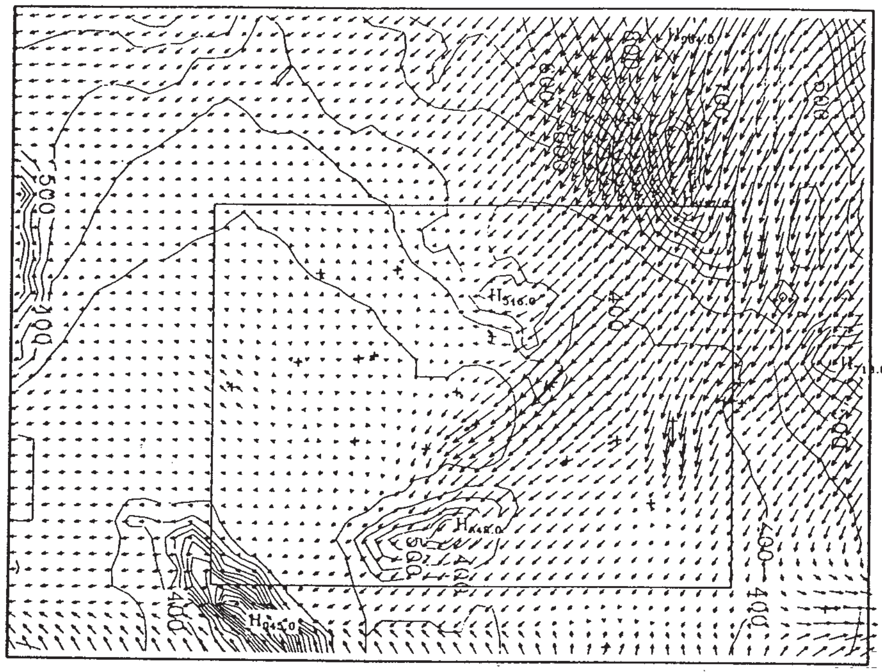
LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 1000-1100 MST



DOMAIN MEAN WIND U = -.41 V = -.20 MPS = .55

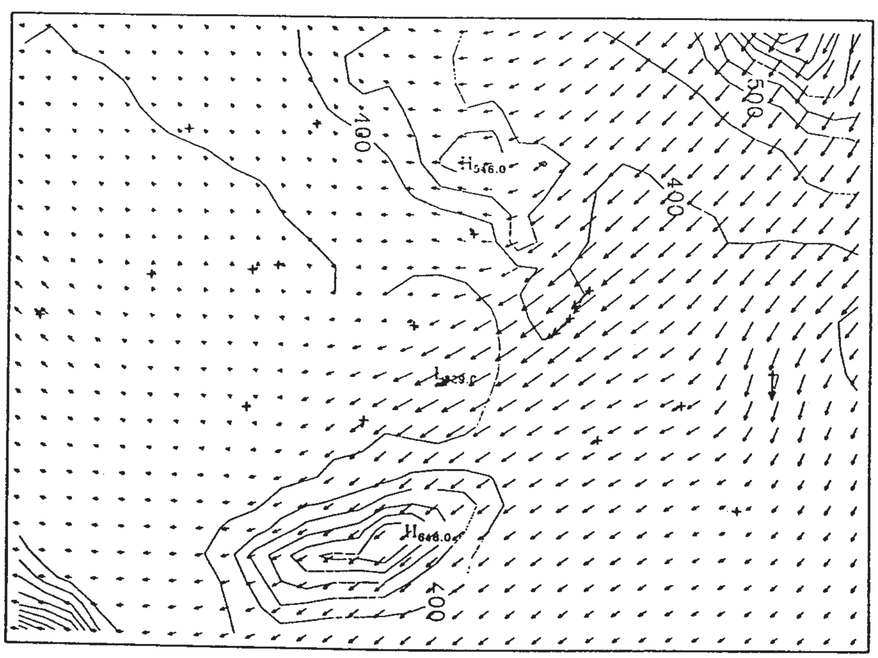
5 M/S

LAYER 1 DWM WIND FIELD (m/s) DEC. 17, 1994 11 – 12 MST
MAG CO UAM AIRSHED IS INSET



LAYER 1 UAM WIND FIELD (m/s) DEC. 17, 1994 1100–1200 MST

.500E+01
MAXIMUM VECTOR



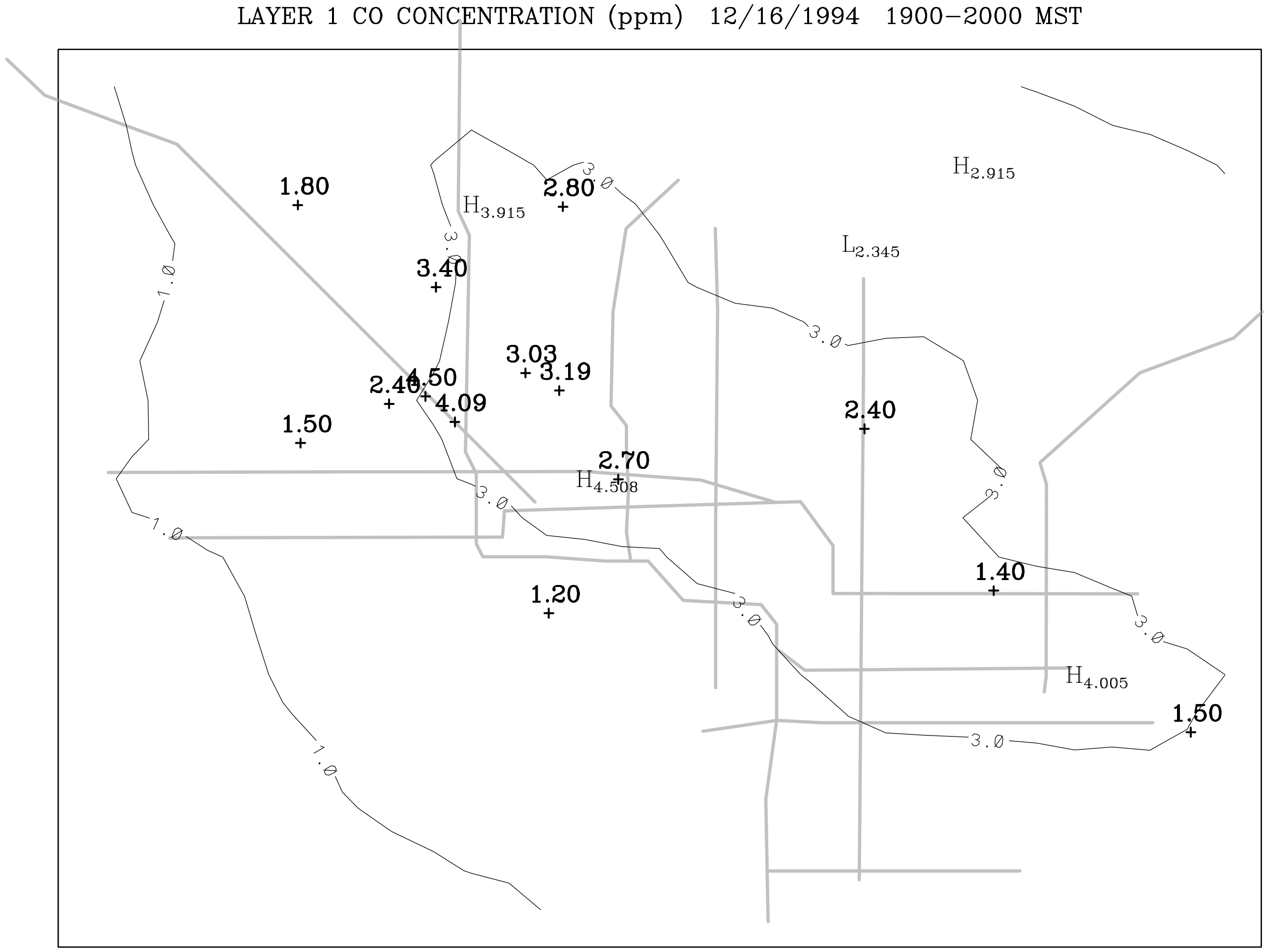
DOMAIN MEAN WIND U = –.67 V = –.40 MPS = .89

5 M/S

Appendix IV-ii

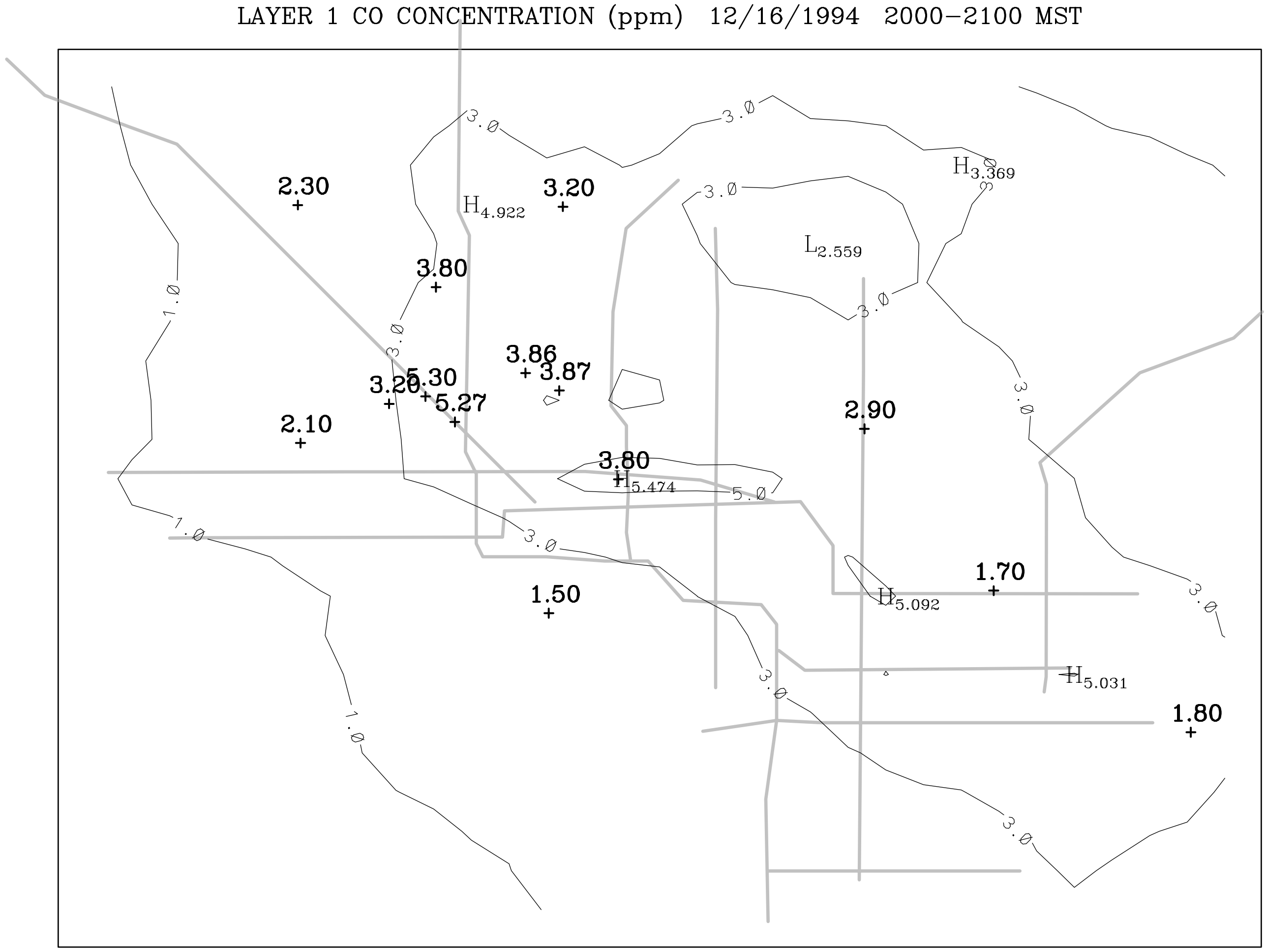
The plots shown here are the simulated (UAM only) and observed CO concentrations. The plus signs indicate the locations of the monitoring sites. These hourly plots are from hour 2000 on December 16, 1994 to hour1200 on December 17, 1994.

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 1900–2000 MST



SIMULATED MAX 4.51 MIN .50 AVG 2.19 MAX AT (15,13)
OBSERVED MAX 4.50 MIN 1.20 AVG 2.57

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2000–2100 MST



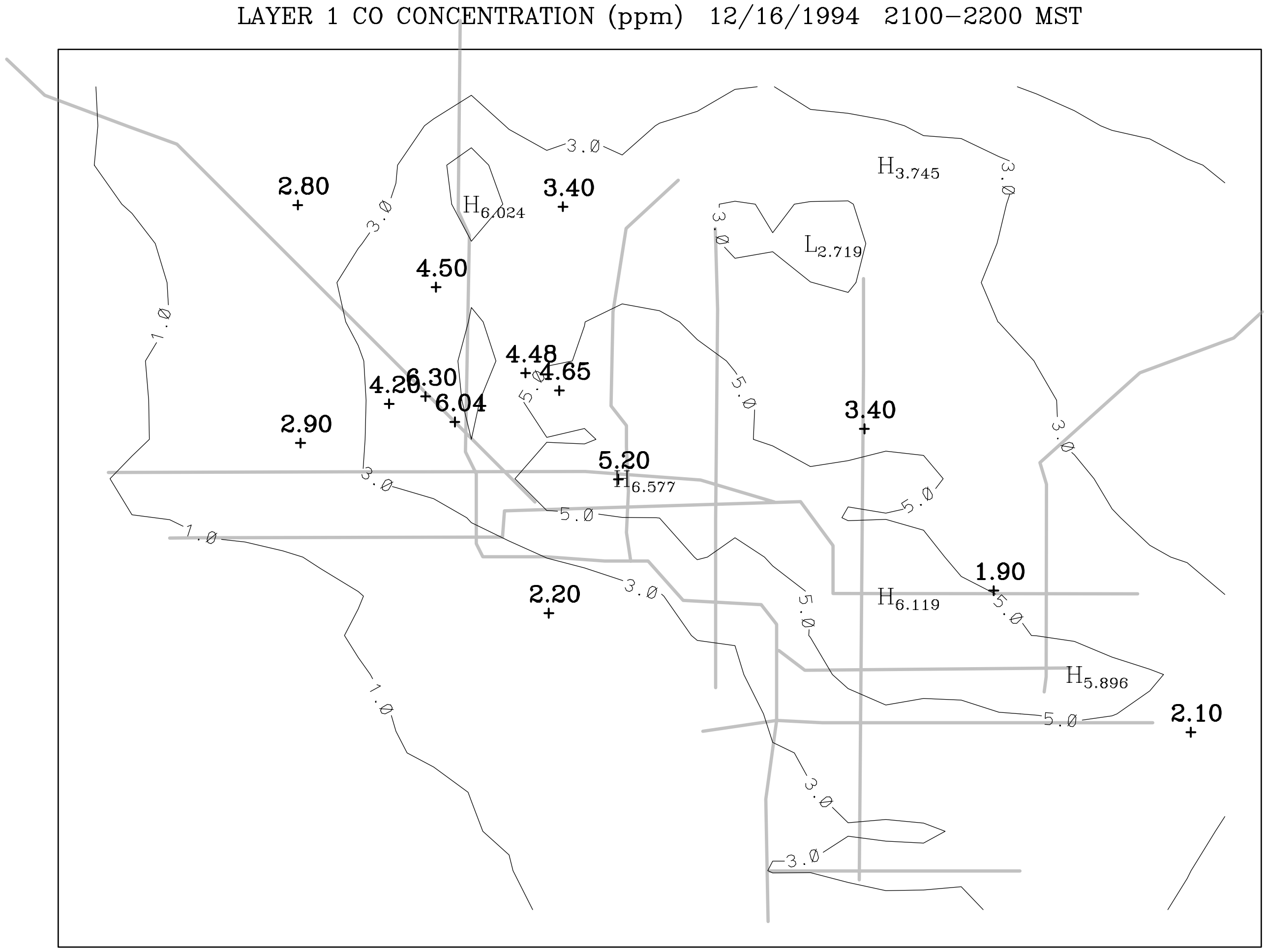
SIMULATED MAX 5.47 MIN .46 AVG 2.45

OBSERVED MAX 5.30 MIN 1.50 AVG 3.19

MAX AT (16,13)

UAM ONLY

LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2100–2200 MST

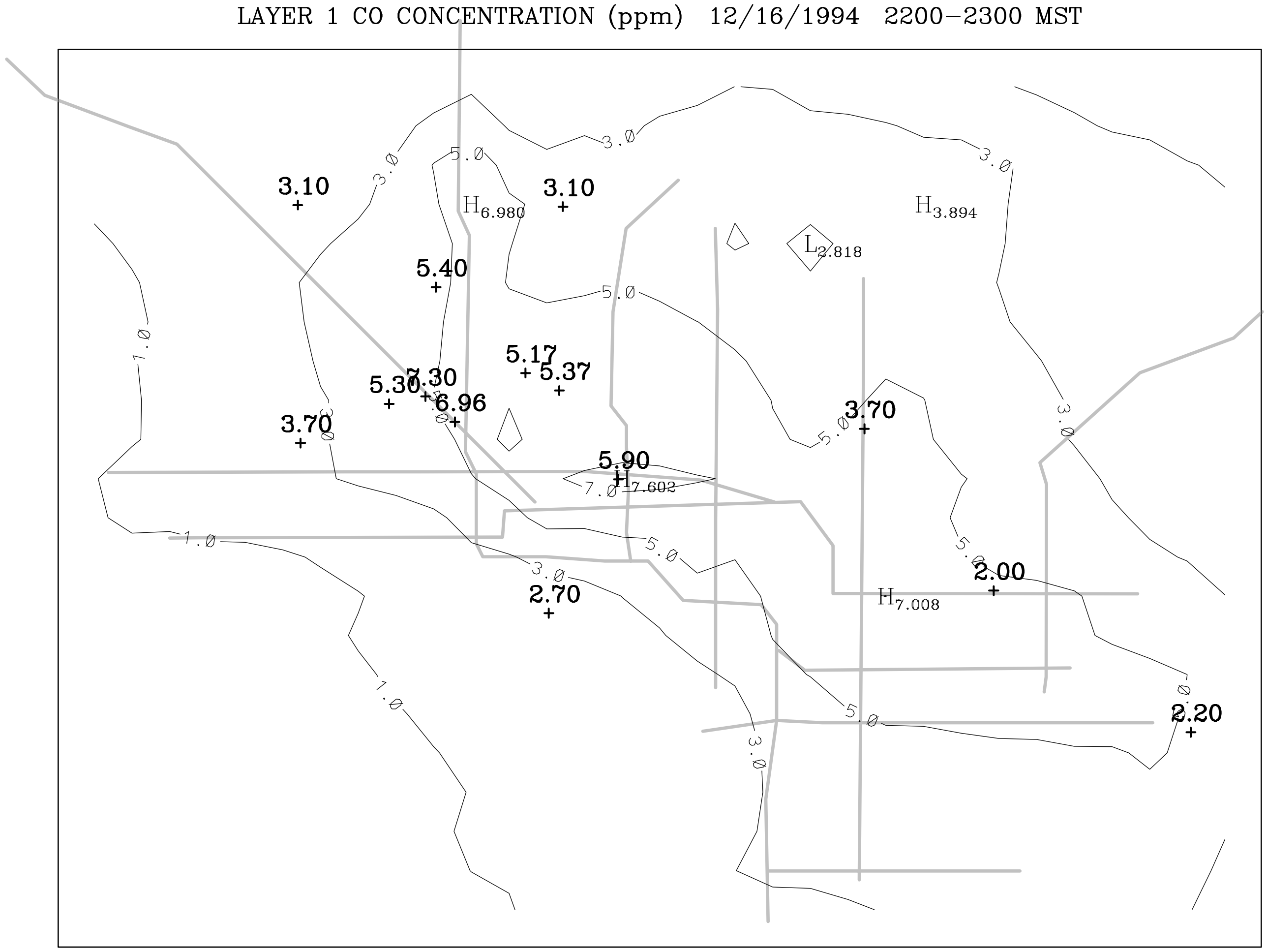


SIMULATED MAX 6.58 MIN .45 AVG 2.75

OBSERVED MAX 6.30 MIN 1.90 AVG 3.86

MAX AT (16,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2200-2300 MST



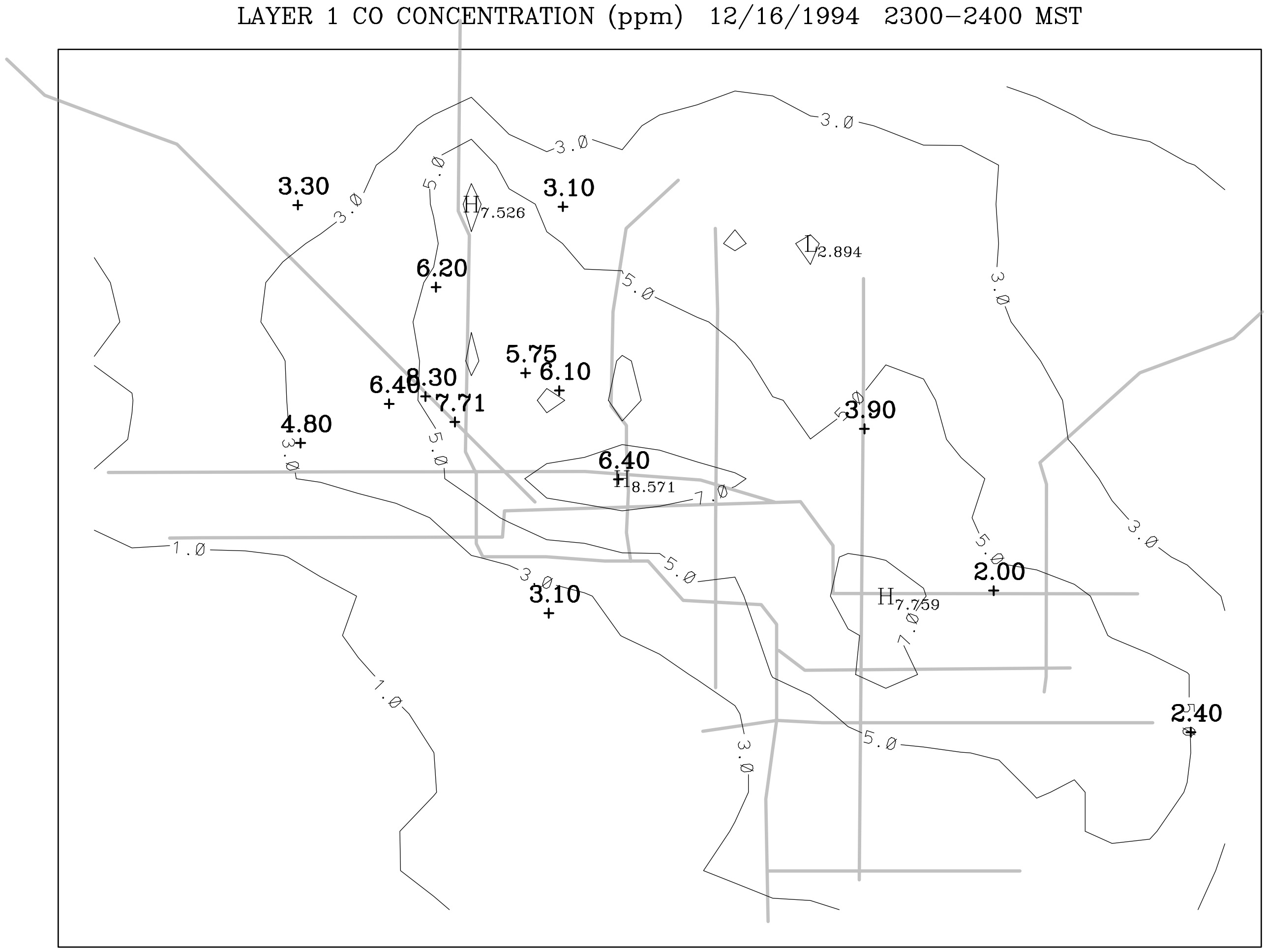
SIMULATED MAX 7.60 MIN .46 AVG 2.99

OBSERVED MAX 7.30 MIN 2.00 AVG 4.42

MAX AT (16,13)

UAM ONLY

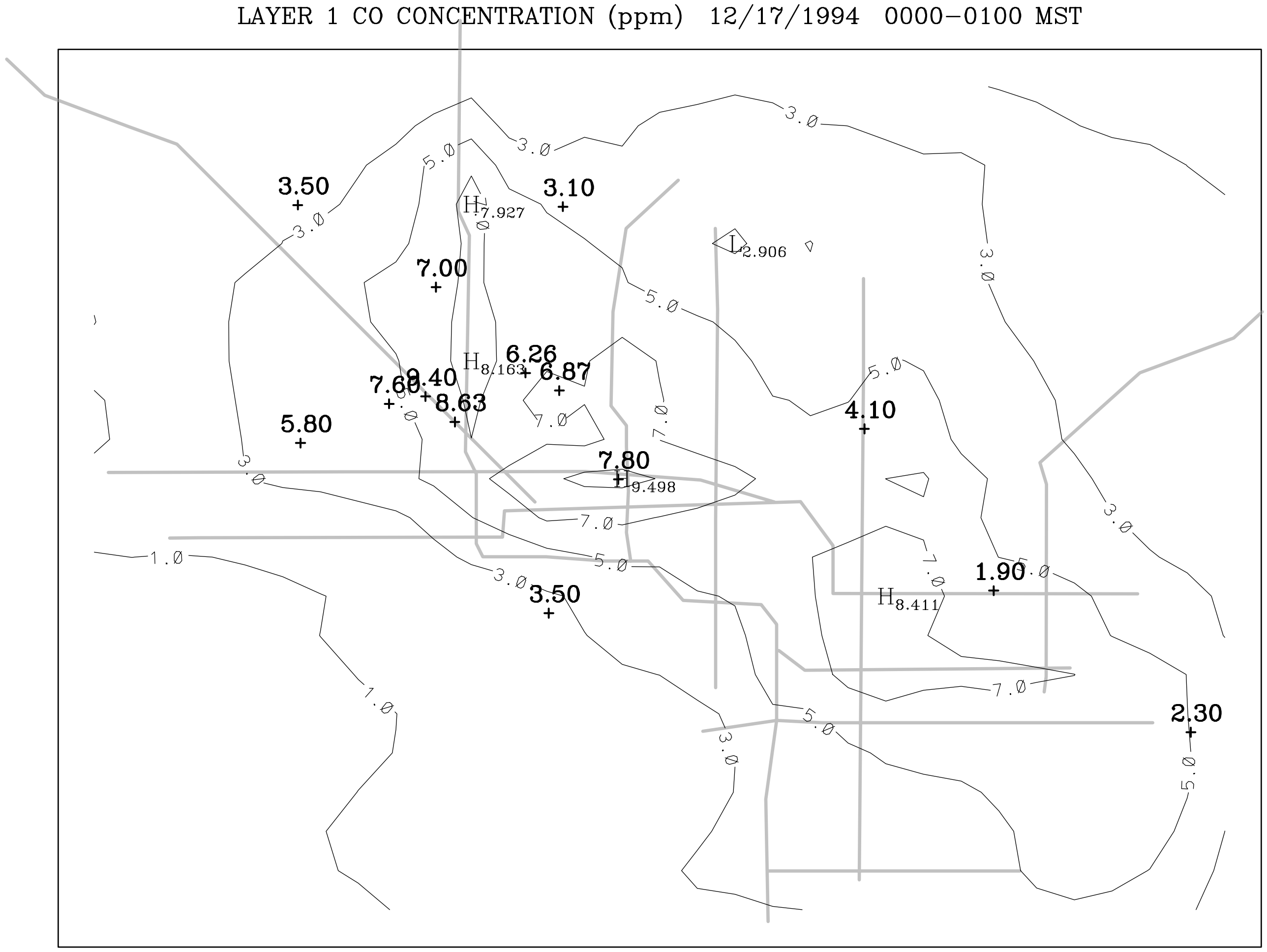
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2300–2400 MST



SIMULATED MAX 8.57 MIN .46 AVG 3.18 MAX AT (16,13)

OBSERVED MAX 8.30 MIN 2.00 AVG 4.96

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0000–0100 MST



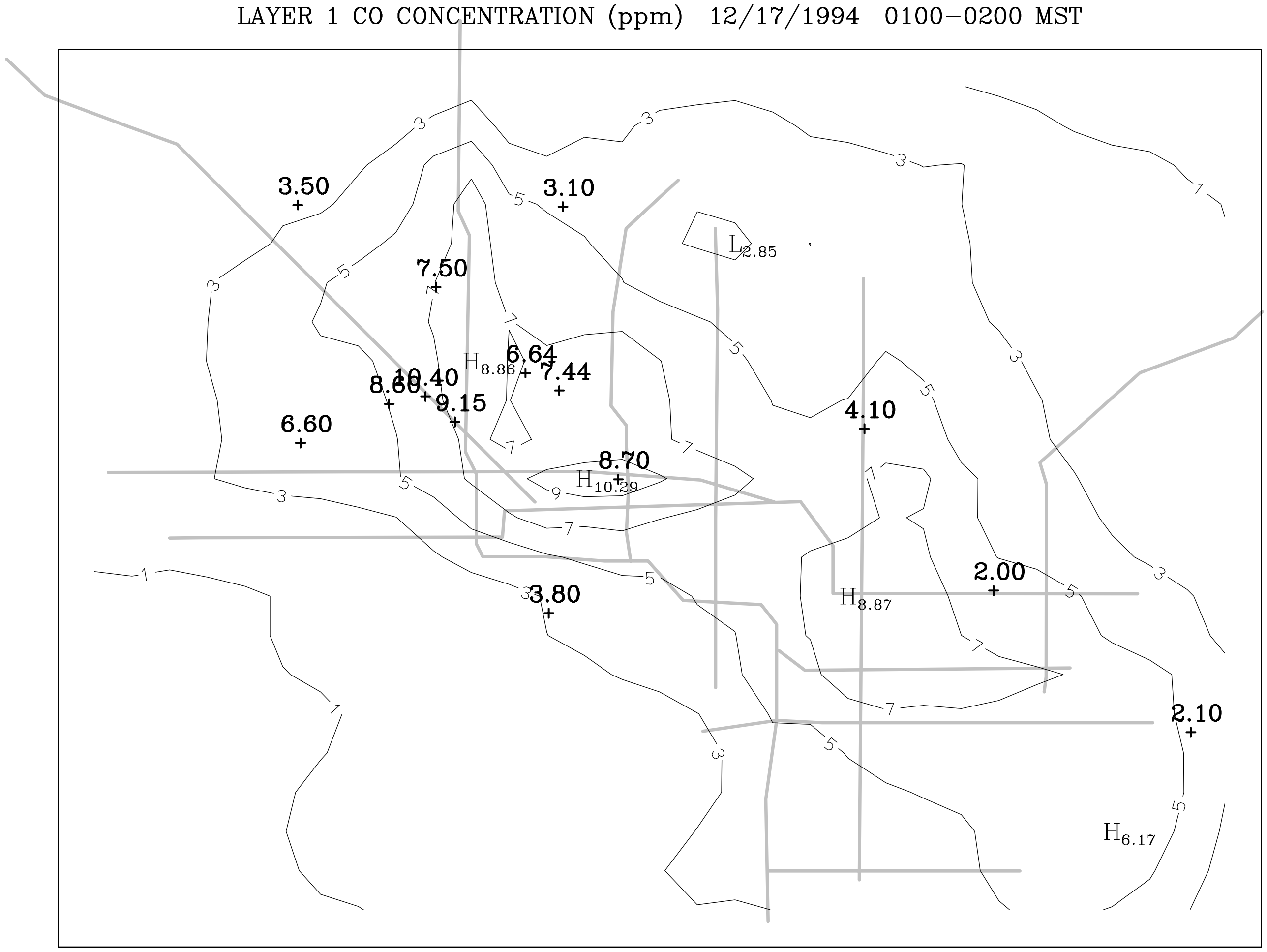
SIMULATED MAX 9.50 MIN .47 AVG 3.37

OBSERVED MAX 9.40 MIN 1.90 AVG 5.55

MAX AT (16,13)

UAM ONLY

LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0100–0200 MST



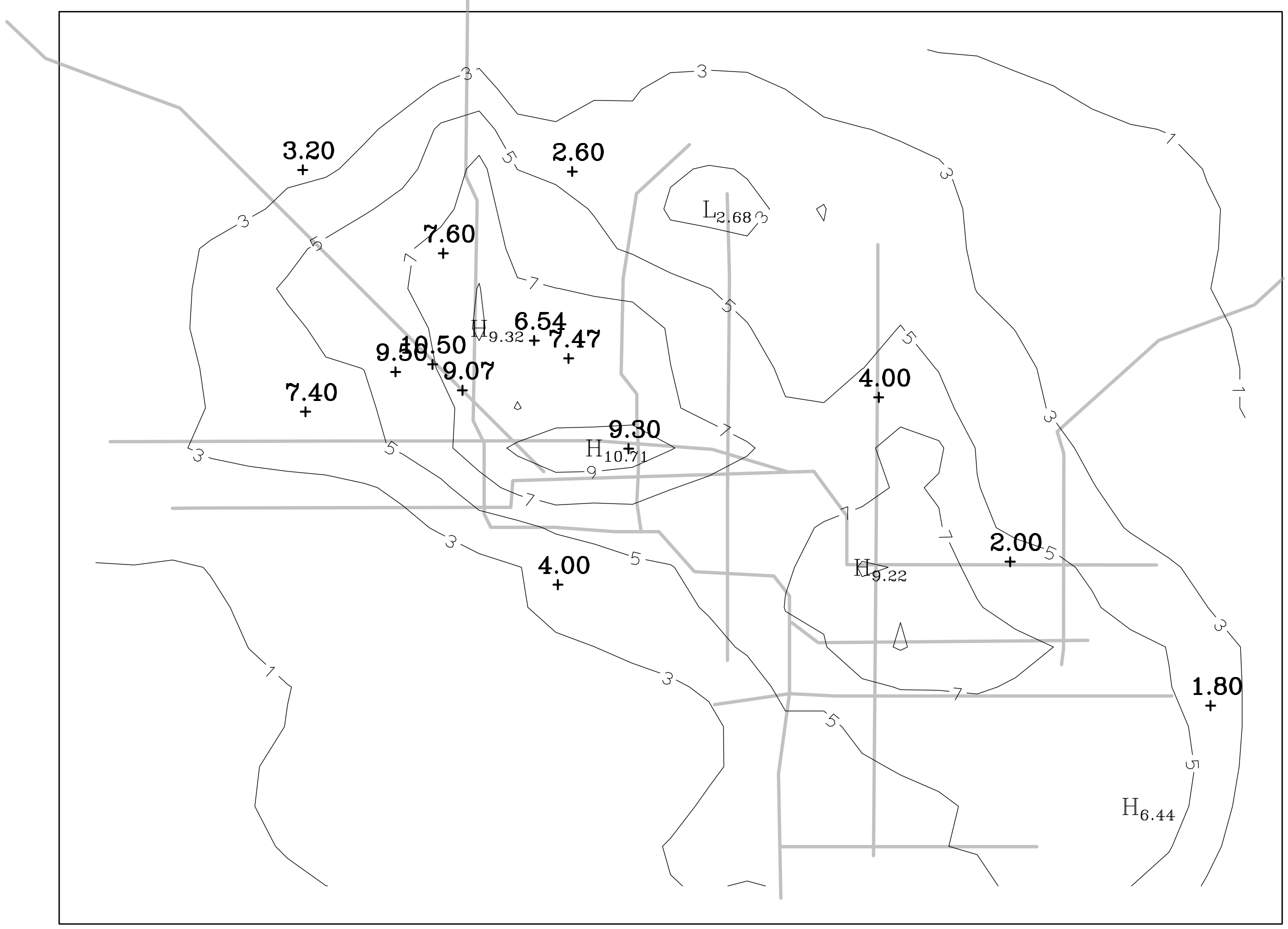
SIMULATED MAX 10.29 MIN .47 AVG 3.49

OBSERVED MAX 10.40 MIN 2.00 AVG 5.97

MAX AT (15,13)

UAM ONLY

LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0200–0300 MST



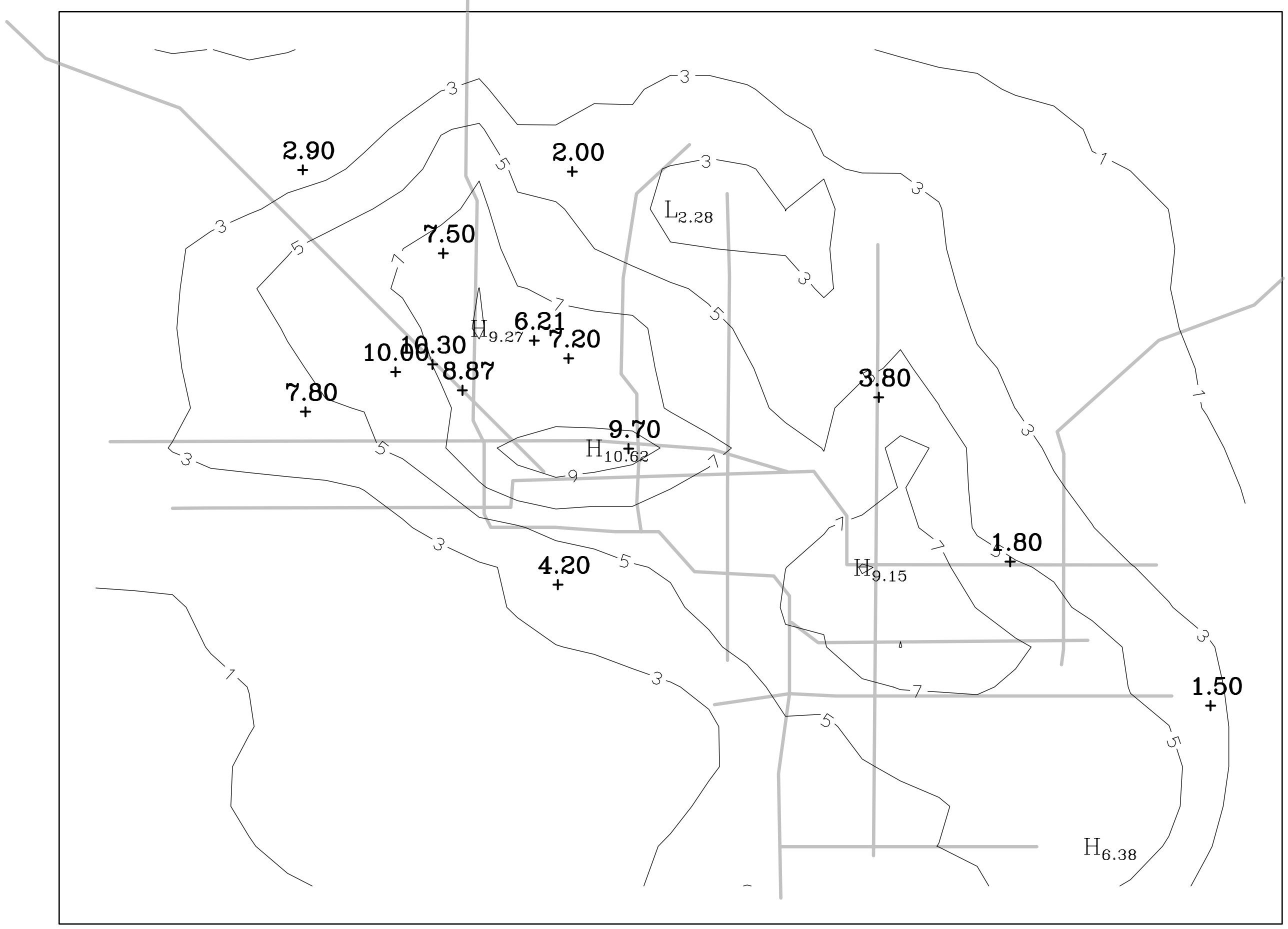
SIMULATED MAX 10.71 MIN .47 AVG 3.53

OBSERVED MAX 10.50 MIN 1.80 AVG 6.07

MAX AT (15,13)

UAM ONLY

LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0300−0400 MST

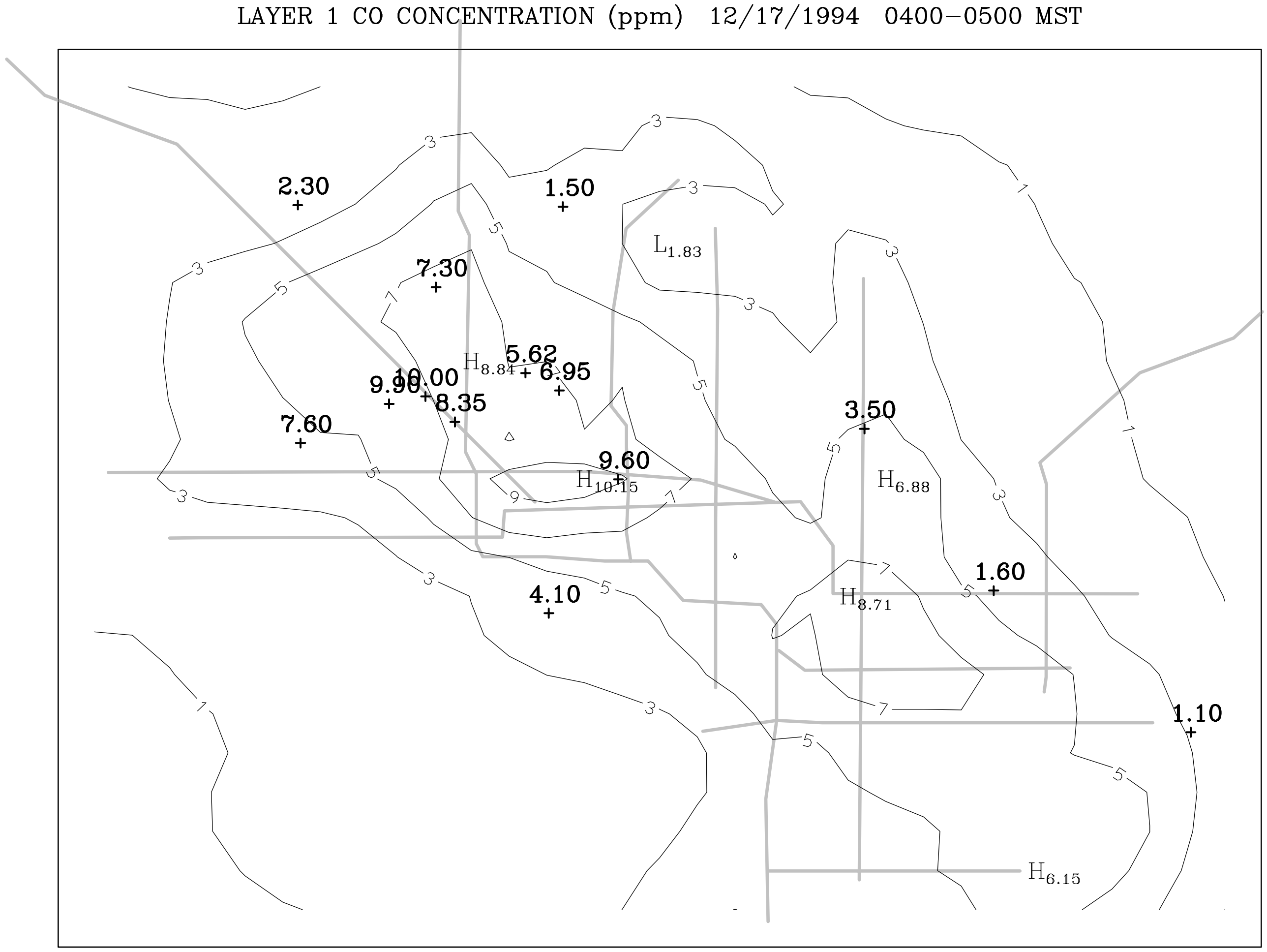


SIMULATED MAX 10.62 MIN .48 AVG 3.43

OBSERVED MAX 10.30 MIN 1.50 AVG 5.98

MAX AT (15,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0400−0500 MST

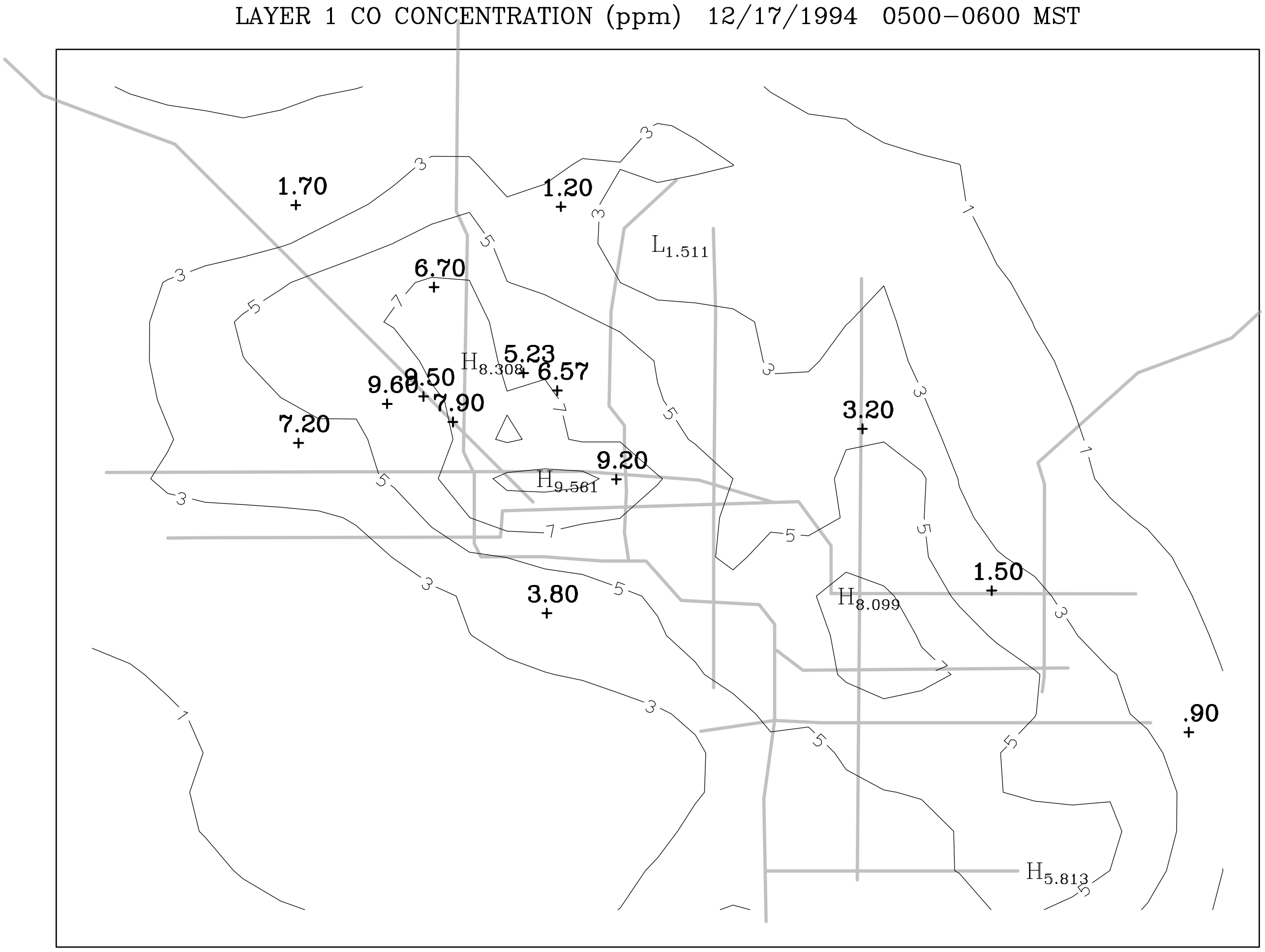


SIMULATED MAX 10.15 MIN .48 AVG 3.23

OBSERVED MAX 10.00 MIN 1.10 AVG 5.67

MAX AT (15,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0500−0600 MST

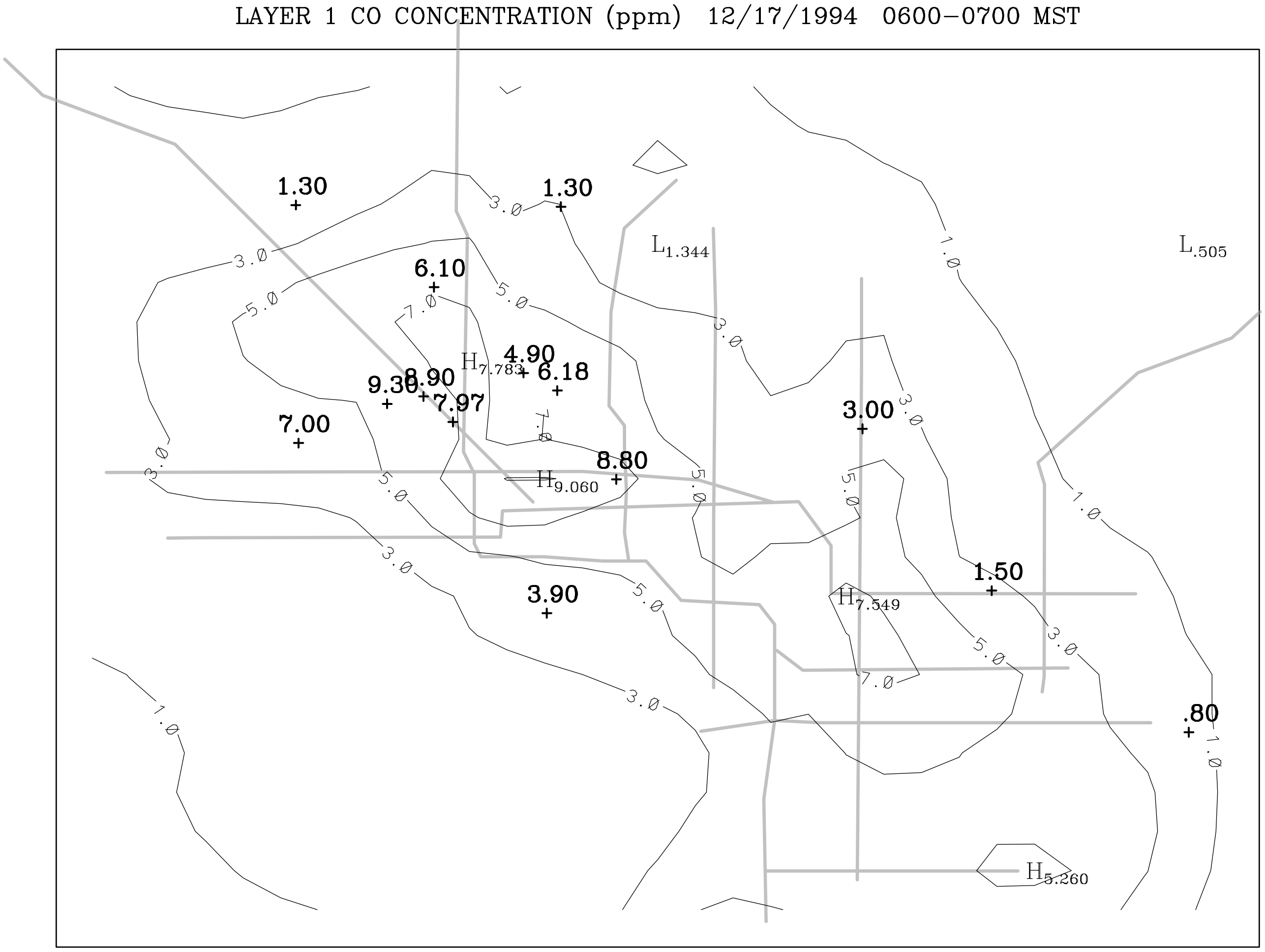


SIMULATED MAX 9.56 MIN .48 AVG 2.99

OBSERVED MAX 9.60 MIN .90 AVG 5.30

MAX AT (14,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0600–0700 MST

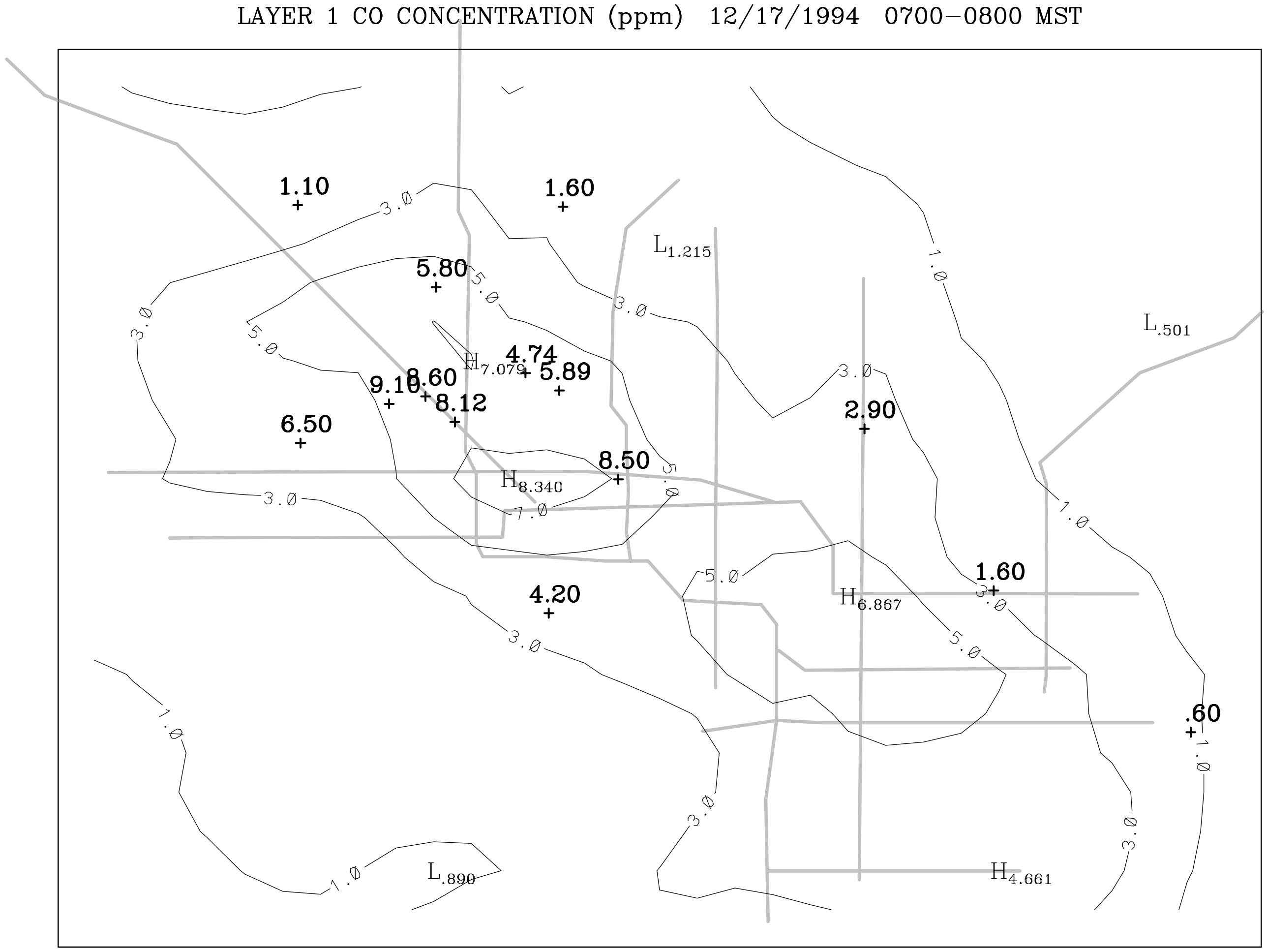


SIMULATED MAX 9.06 MIN .48 AVG 2.78

OBSERVED MAX 9.30 MIN .80 AVG 5.07

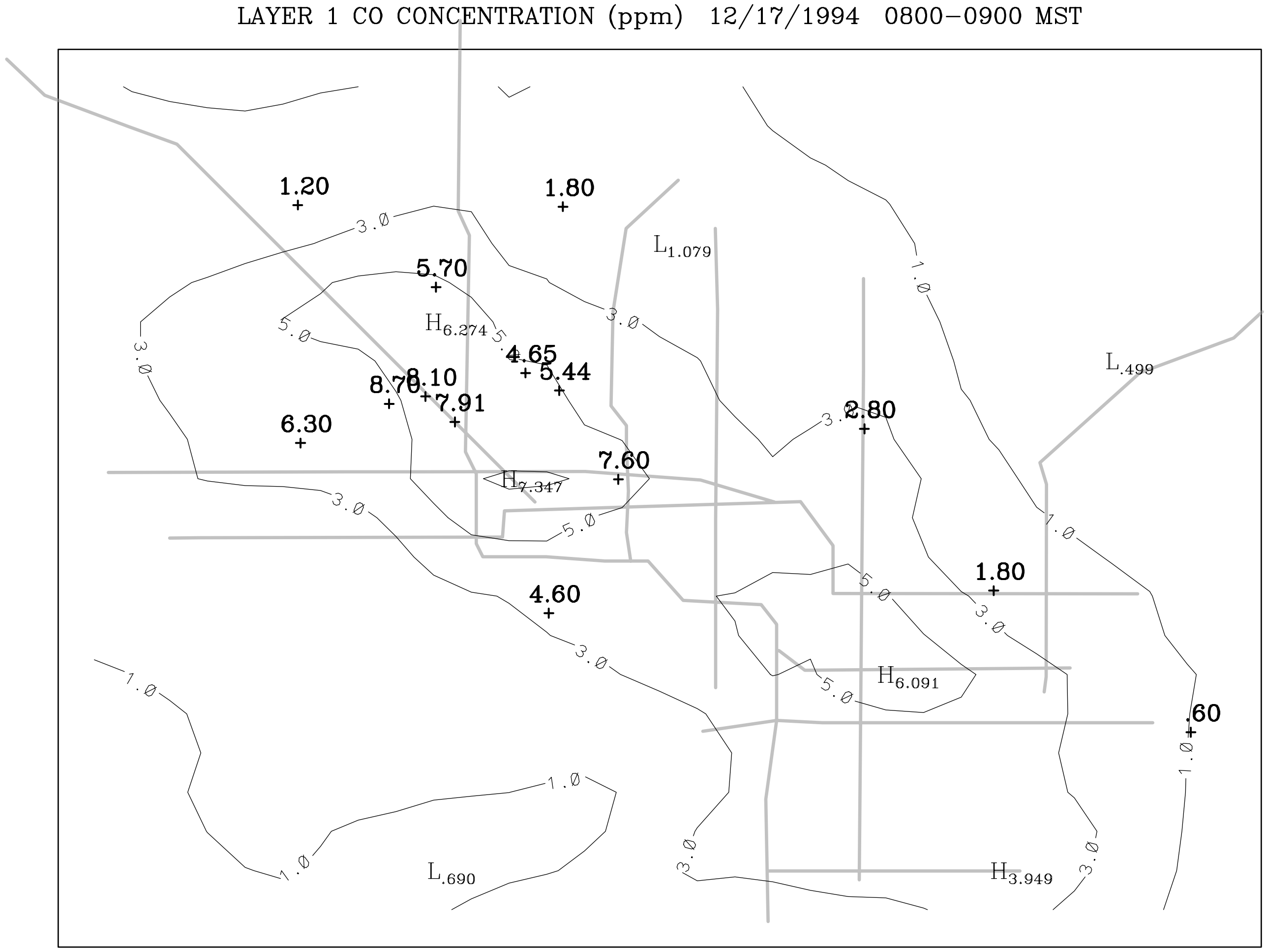
MAX AT (14,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0700–0800 MST



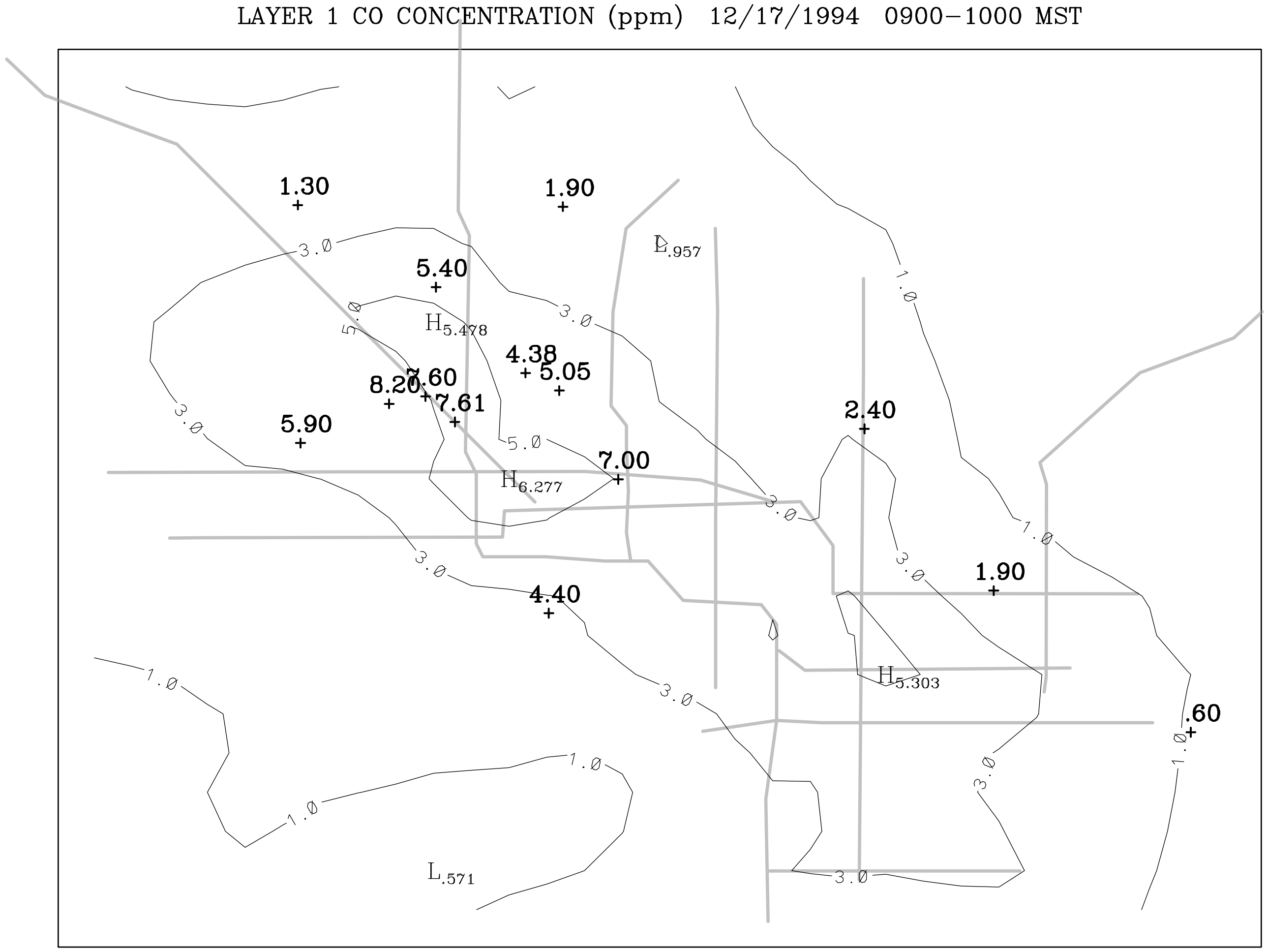
SIMULATED MAX 8.34 MIN .48 AVG 2.54 MAX AT (13,13)
OBSERVED MAX 9.10 MIN .60 AVG 4.95

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0800–0900 MST



SIMULATED MAX 7.35 MIN .49 AVG 2.28 MAX AT (13,13)
OBSERVED MAX 8.70 MIN .60 AVG 4.80

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0900–1000 MST

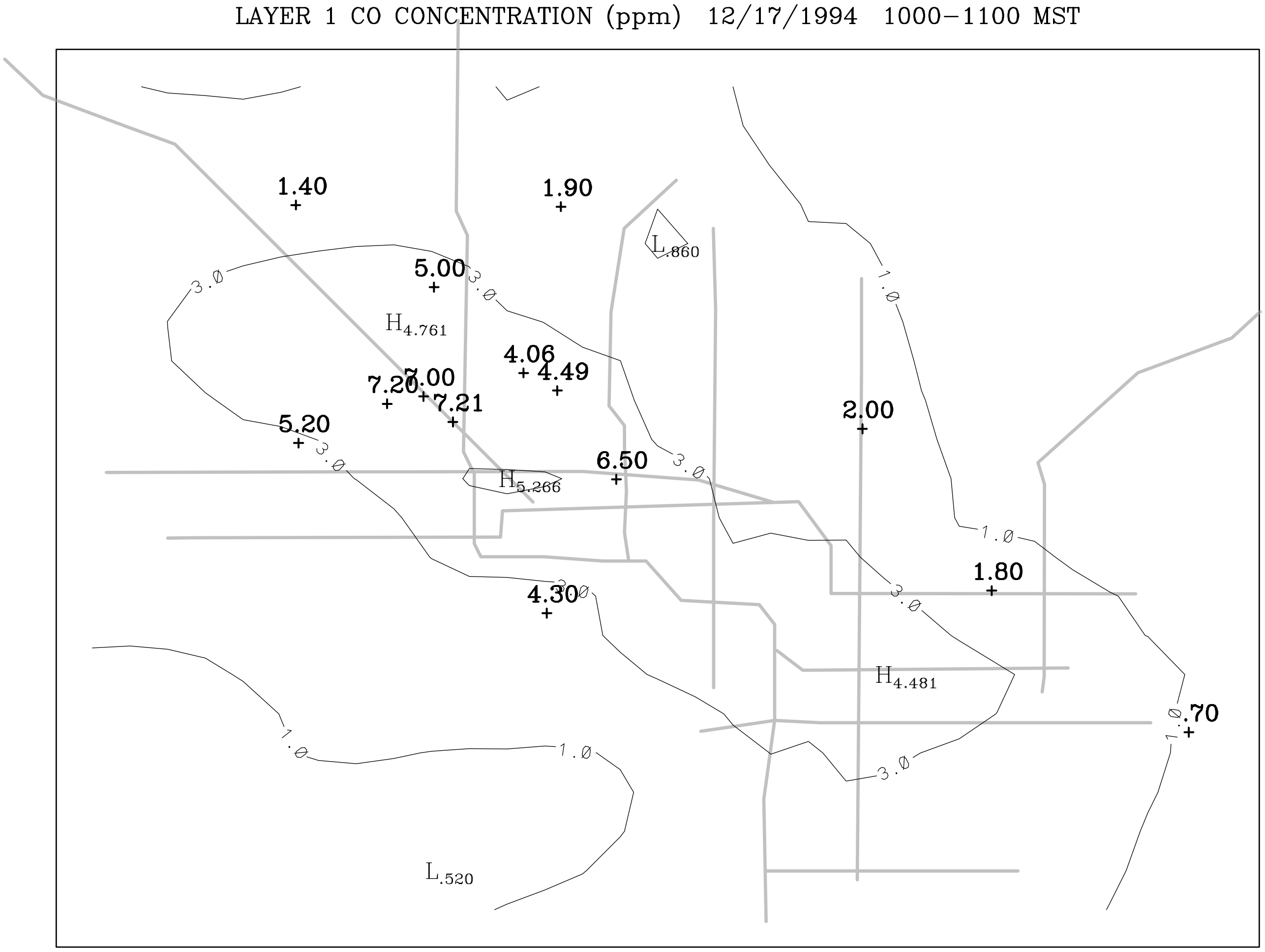


SIMULATED MAX 6.28 MIN .49 AVG 2.03

OBSERVED MAX 8.20 MIN .60 AVG 4.55

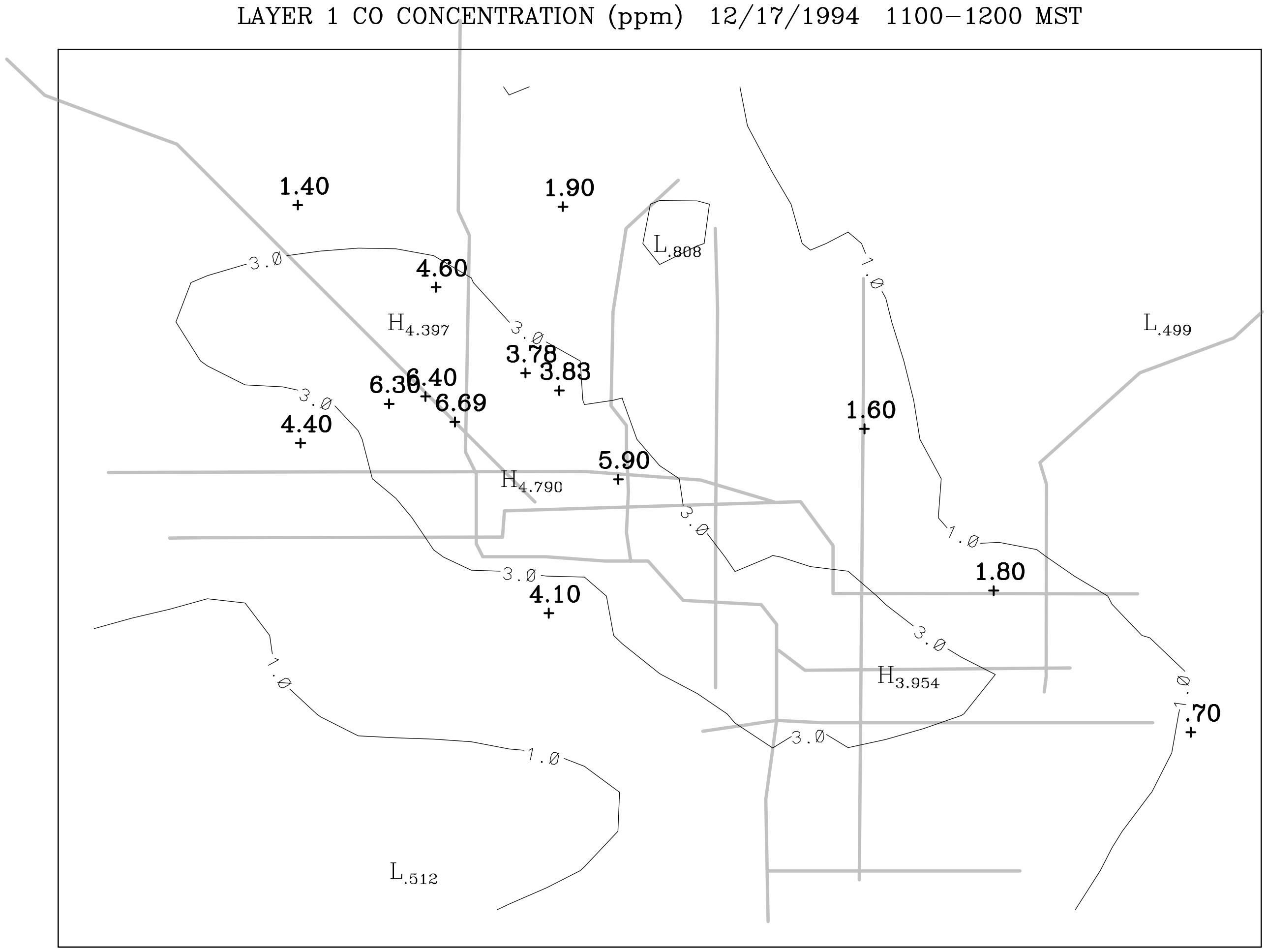
MAX AT (13,13)

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 1000–1100 MST



SIMULATED MAX 5.27 MIN .49 AVG 1.79 MAX AT (13,13)
OBSERVED MAX 7.21 MIN .70 AVG 4.20

UAM ONLY
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 1100–1200 MST

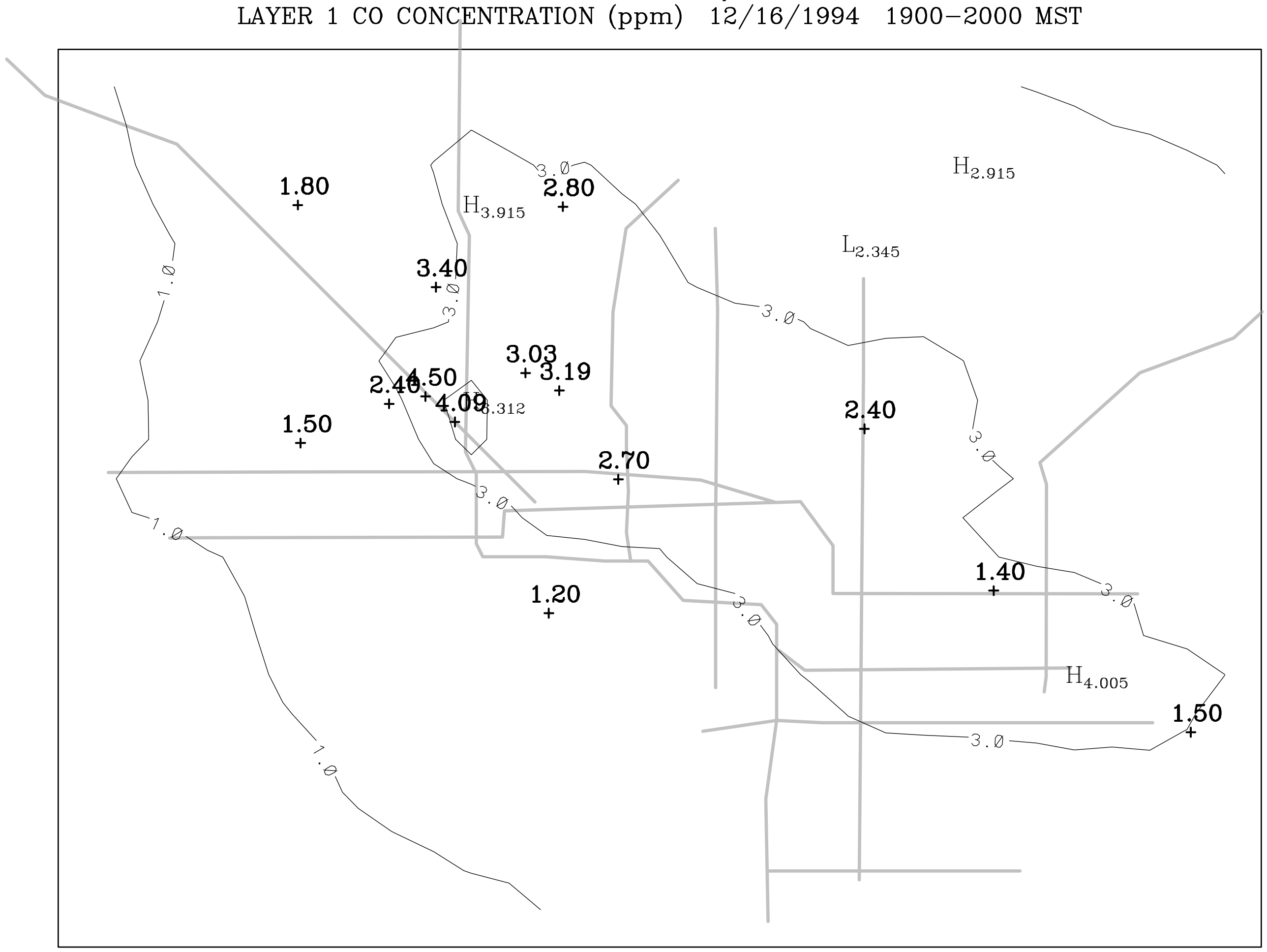


SIMULATED MAX 4.79 MIN .50 AVG 1.67 MAX AT (13,13)
OBSERVED MAX 6.69 MIN .70 AVG 3.81

Appendix IV-iii

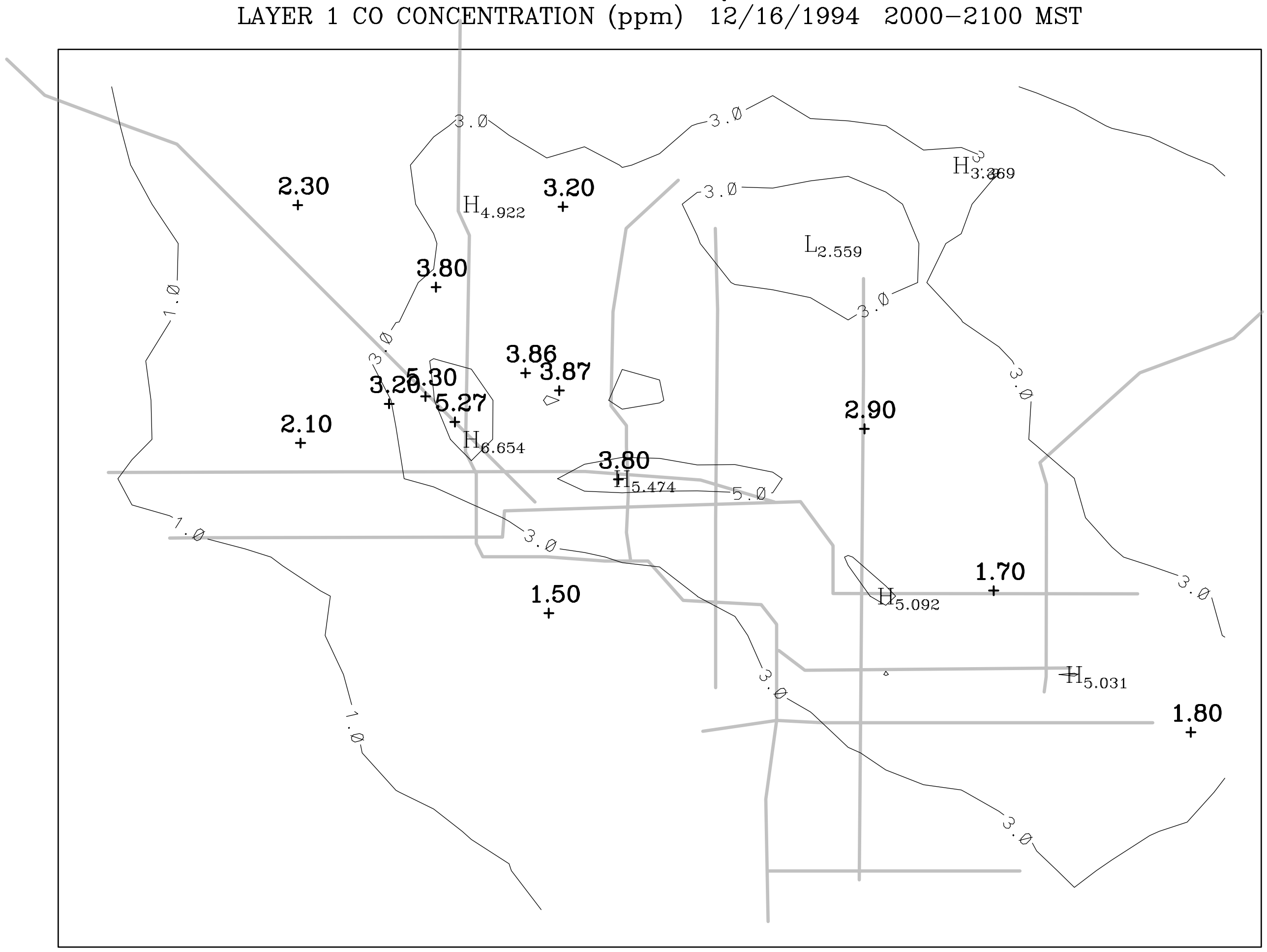
The plots shown here are the simulated (UAM plus CAL3QHC components) and observed CO concentrations. The plus signs indicate the locations of the monitoring sites. These hourly plots are from hour 2000 on December 16, 1994 to hour1200 on December 17, 1994.

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 1900−2000 MST



SIMULATED MAX 6.31 MIN .50 AVG 2.20 MAX AT (12,15)
OBSERVED MAX 4.50 MIN 1.20 AVG 2.57

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2000−2100 MST

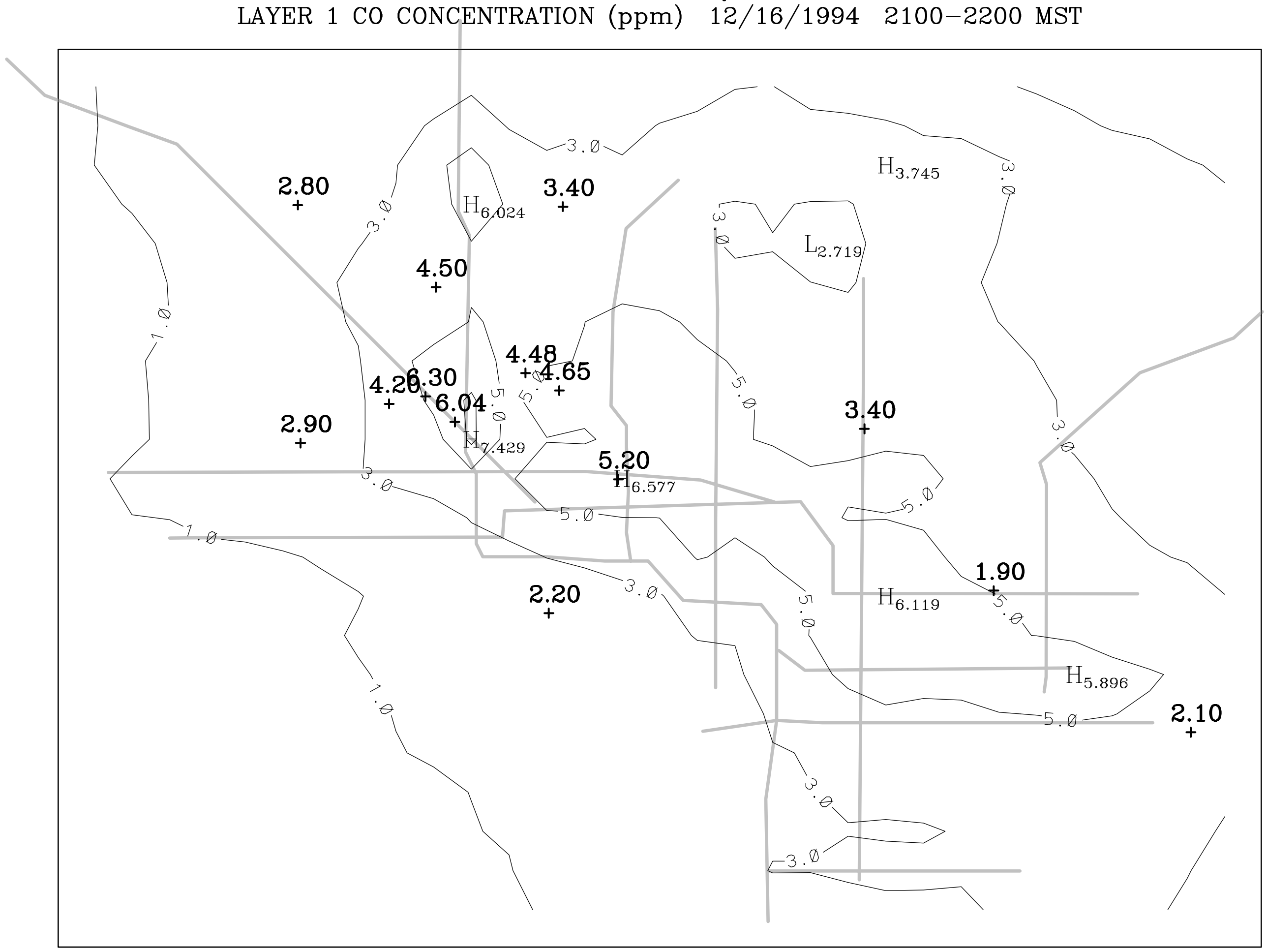


SIMULATED   MAX 6.65   MIN   .46   AVG 2.47

MAX AT (12,14)

OBSERVED MAX 5.30   MIN 1.50   AVG 3.19

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2100–2200 MST

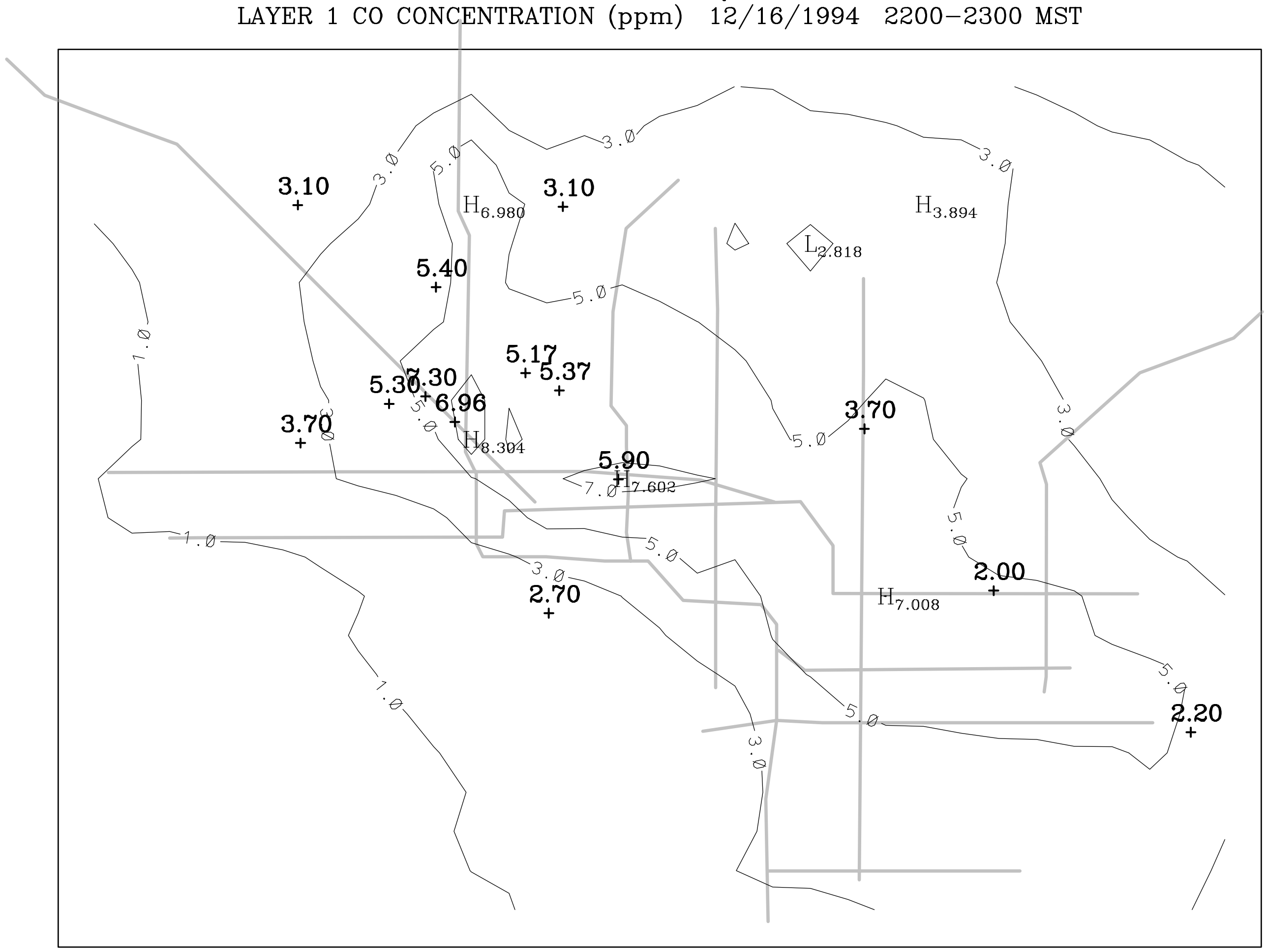


SIMULATED MAX 7.43 MIN .45 AVG 2.76

OBSERVED MAX 6.30 MIN 1.90 AVG 3.86

MAX AT (12,14)

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2200–2300 MST

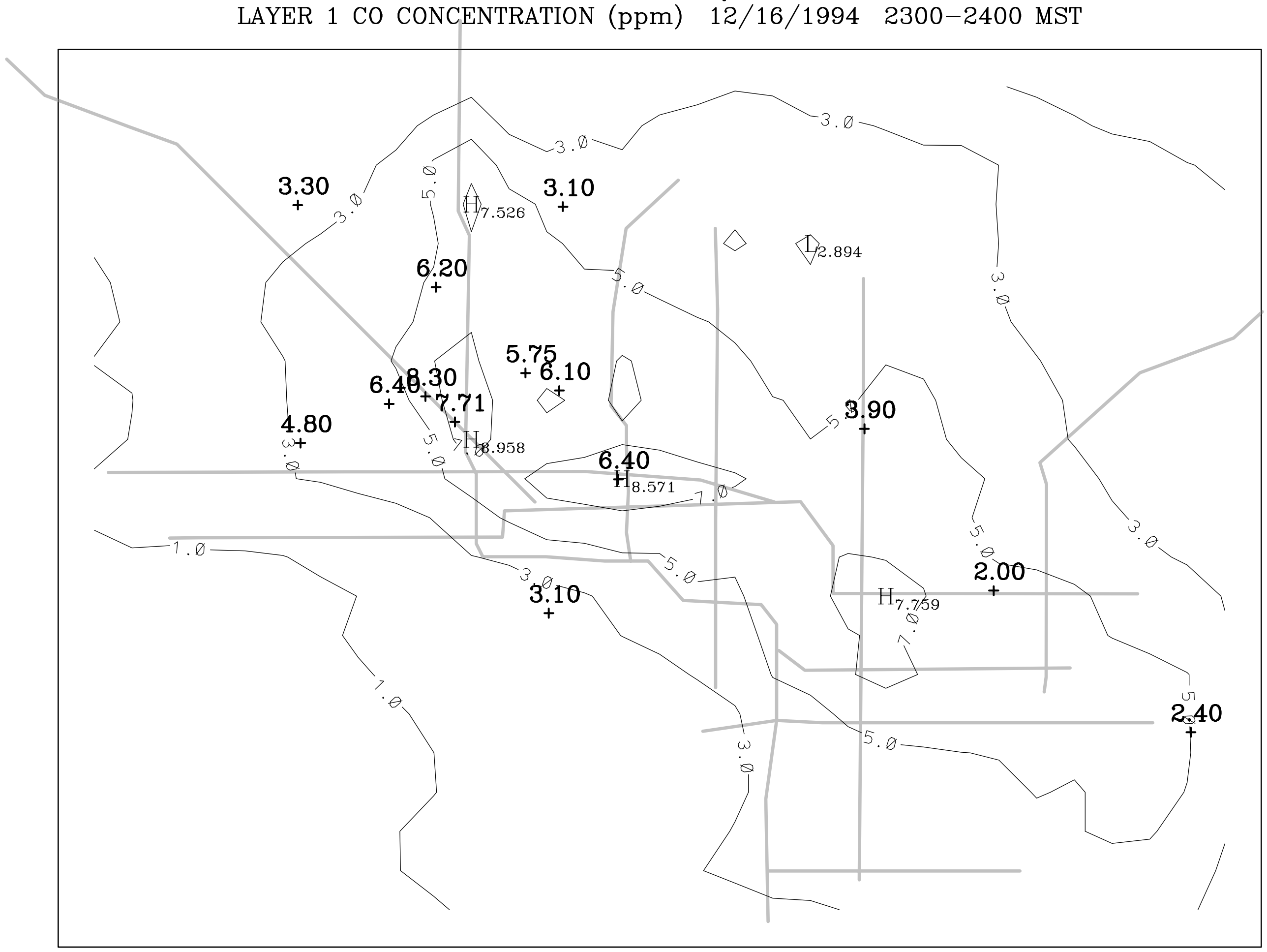


SIMULATED MAX 8.30 MIN .46 AVG 3.00

OBSERVED MAX 7.30 MIN 2.00 AVG 4.42

MAX AT (12,14)

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/16/1994 2300–2400 MST

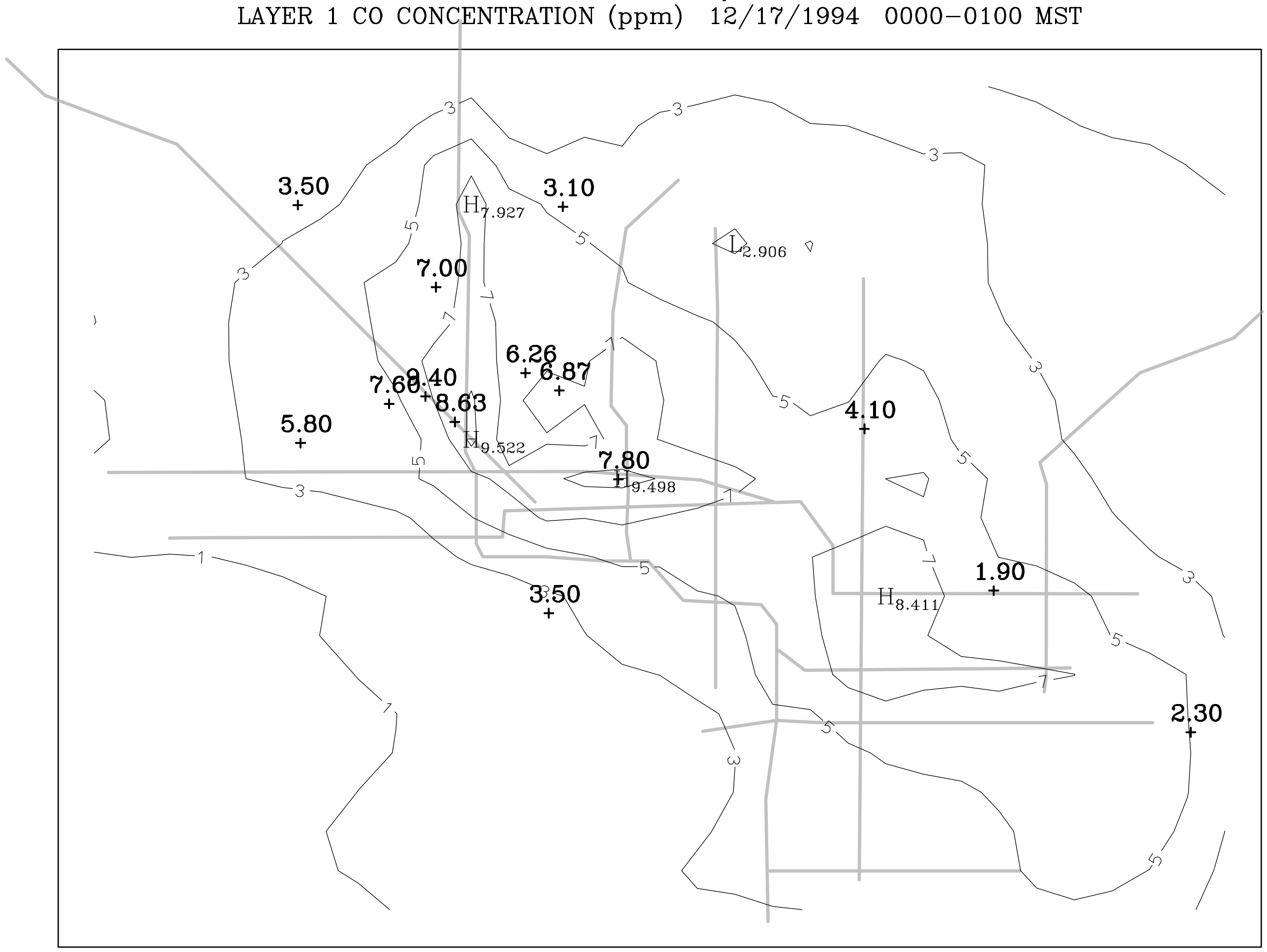


SIMULATED MAX 8.96 MIN .46 AVG 3.20

MAX AT (12,14)

OBSERVED MAX 8.30 MIN 2.00 AVG 4.96

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0000–0100 MST

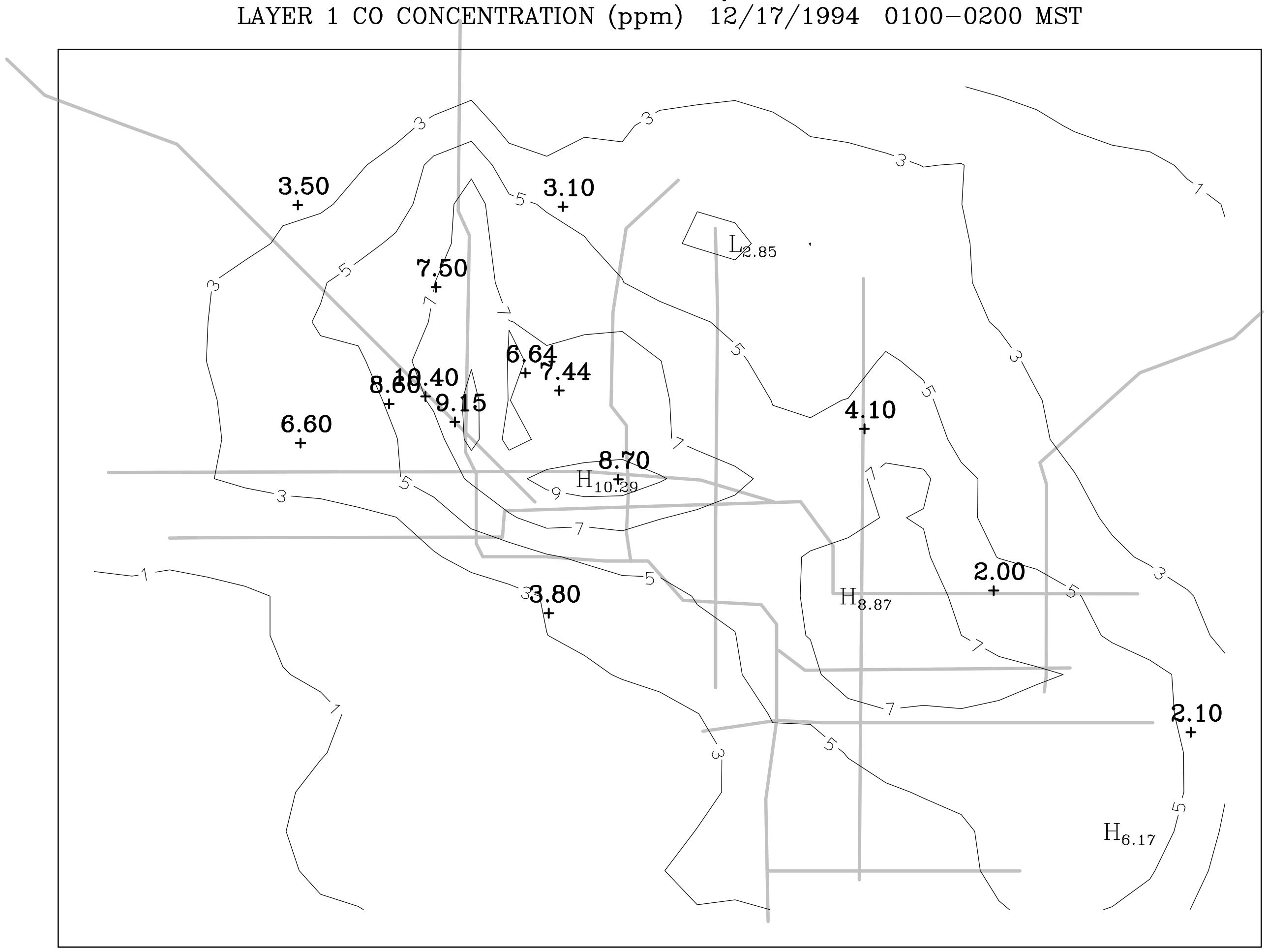


SIMULATED   MAX 9.52   MIN   .47   AVG 3.38

OBSERVED   MAX 9.40   MIN 1.90   AVG 5.55

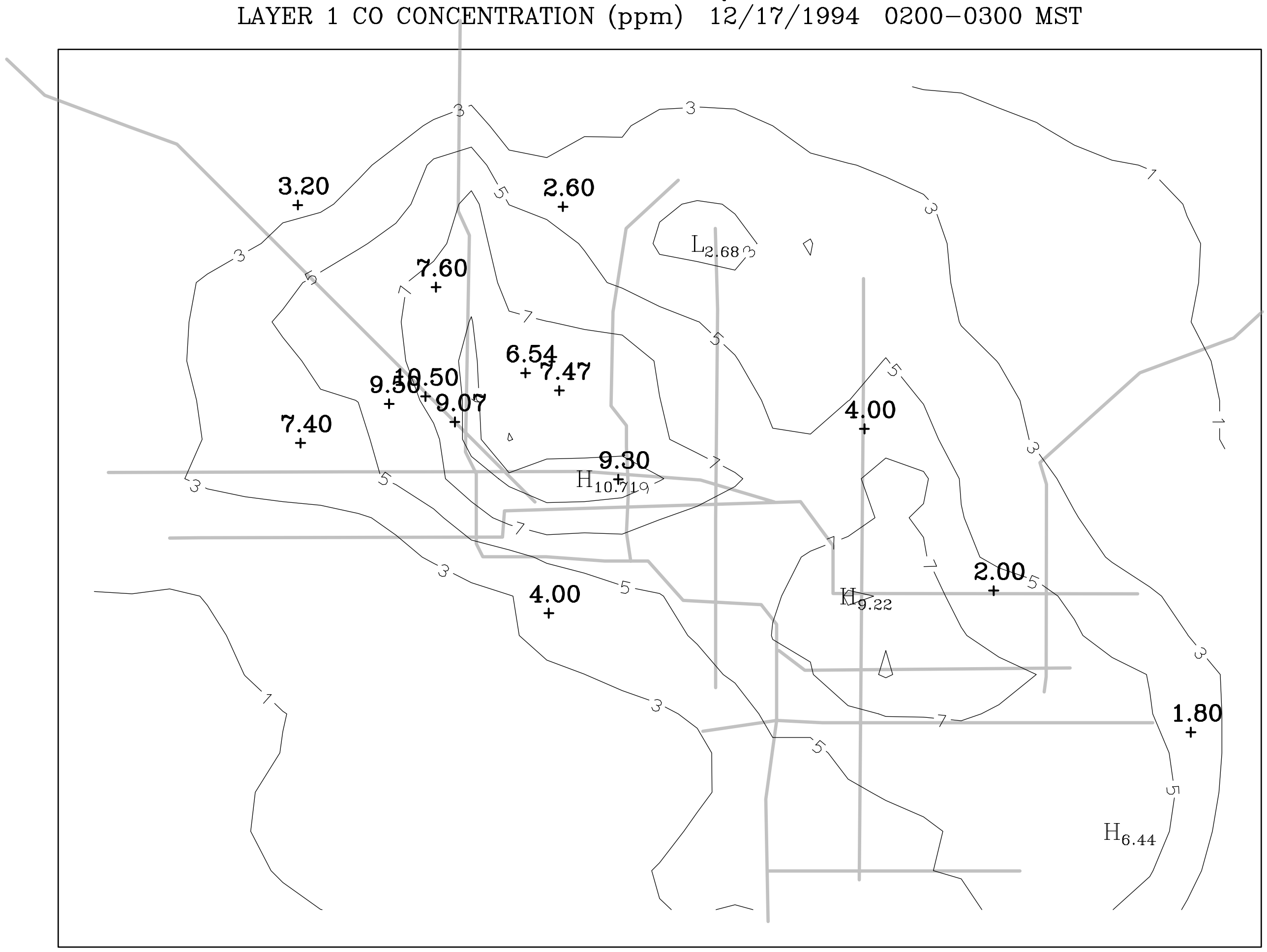
MAX AT (12,14)

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0100–0200 MST



SIMULATED MAX 10.29 MIN .47 AVG 3.50 MAX AT (15,13)
OBSERVED MAX 10.40 MIN 2.00 AVG 5.97

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0200–0300 MST

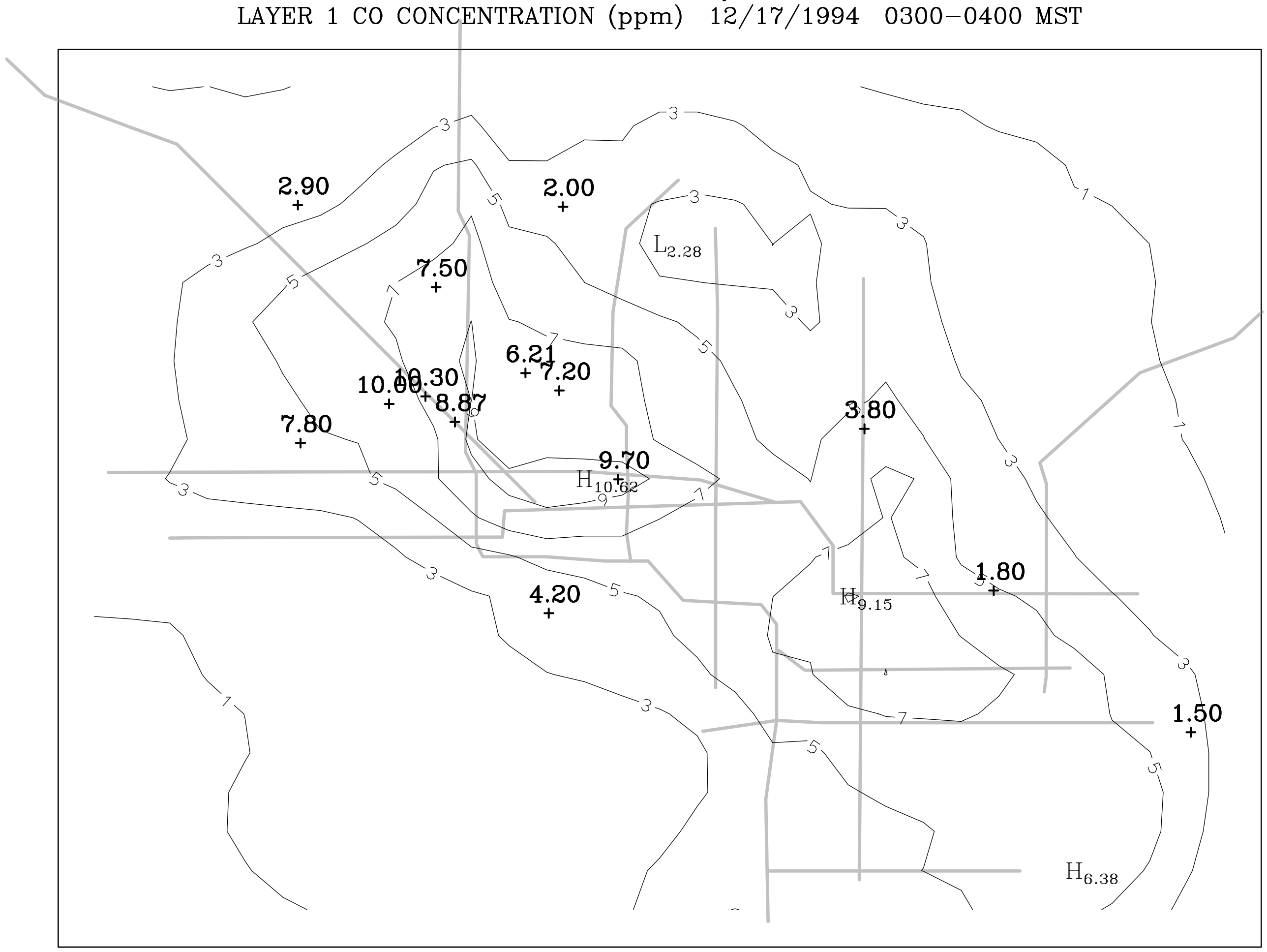


SIMULATED MAX 10.71 MIN .47 AVG 3.54

MAX AT (15,13)

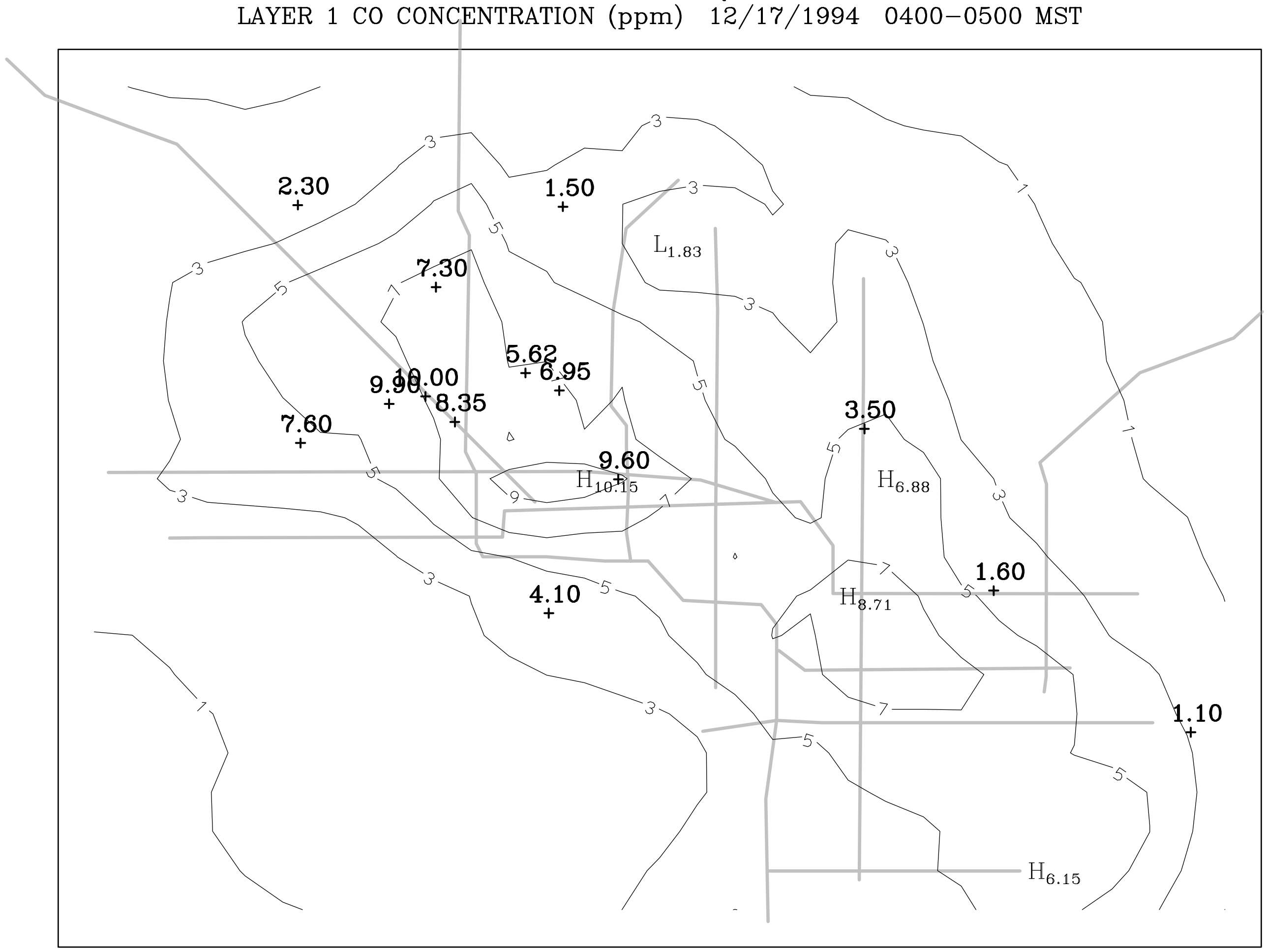
OBSERVED MAX 10.50 MIN 1.80 AVG 6.07

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0300–0400 MST



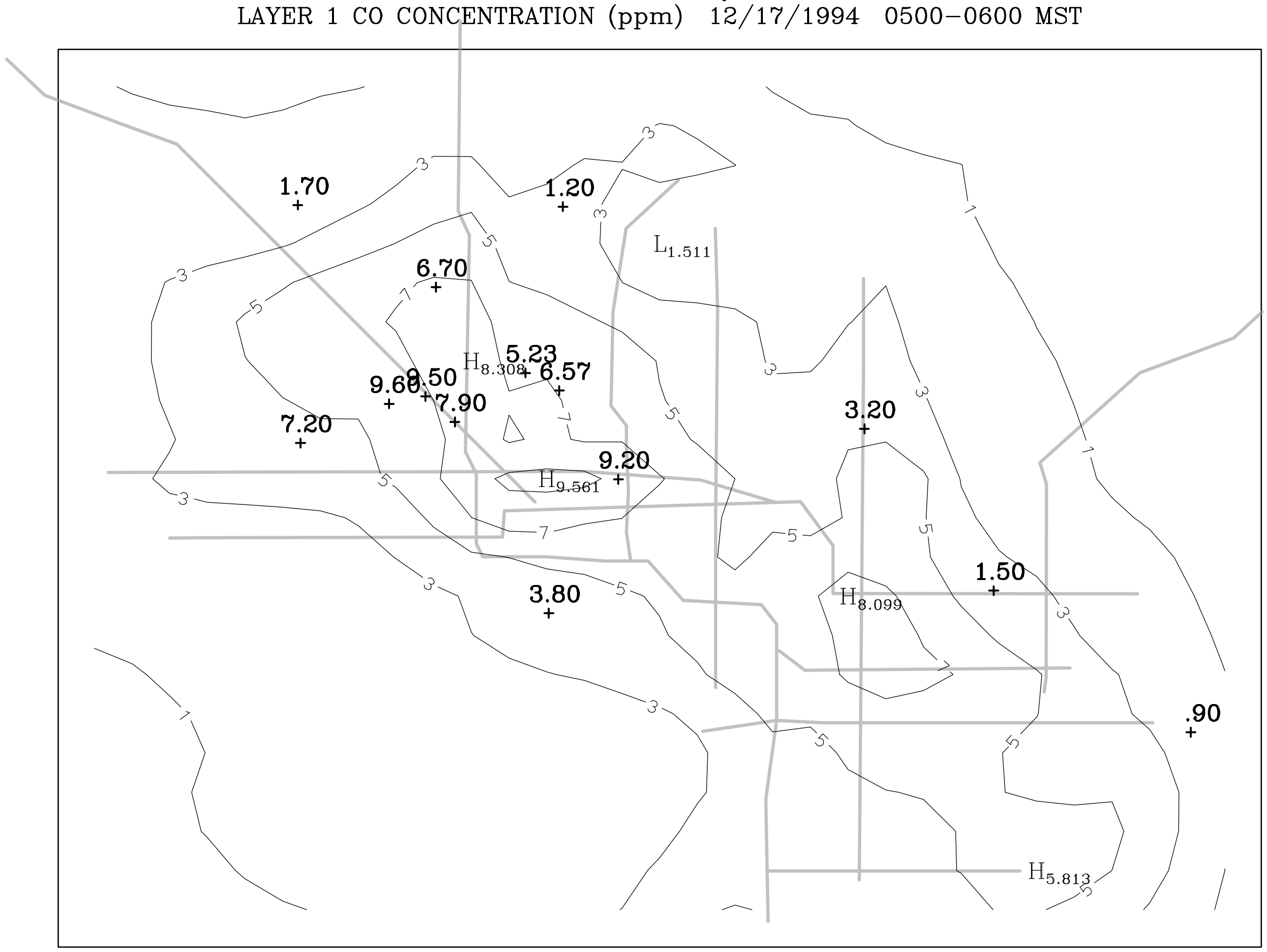
SIMULATED MAX 10.62 MIN .48 AVG 3.44 MAX AT (15,13)
OBSERVED MAX 10.30 MIN 1.50 AVG 5.98

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0400−0500 MST



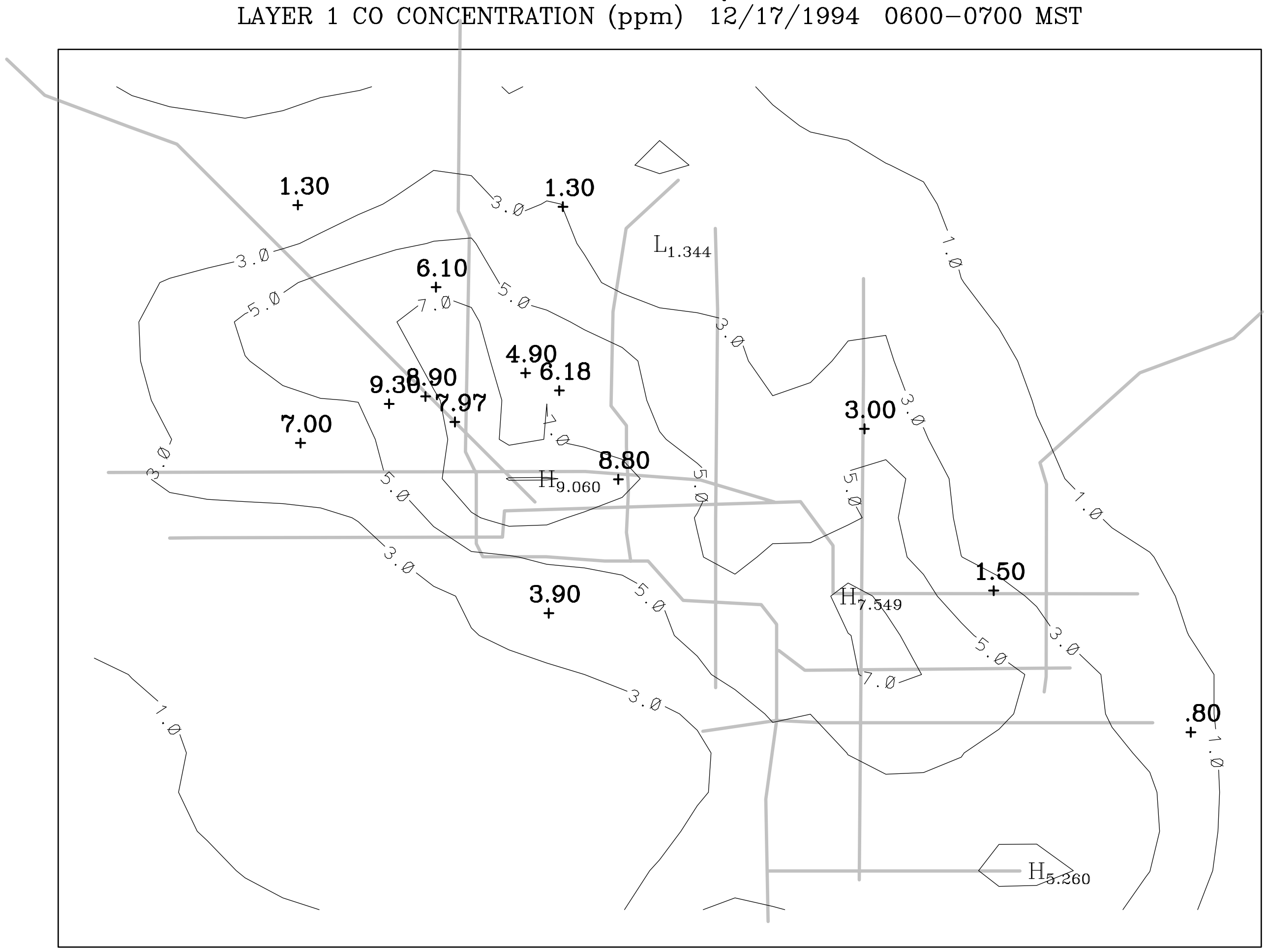
SIMULATED MAX 10.15 MIN .48 AVG 3.23 MAX AT (15,13)
OBSERVED MAX 10.00 MIN 1.10 AVG 5.67

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0500–0600 MST



SIMULATED   MAX   9.56   MIN   .48   AVG   2.99   MAX AT (14,13)
OBSERVED   MAX   9.60   MIN   .90   AVG   5.30

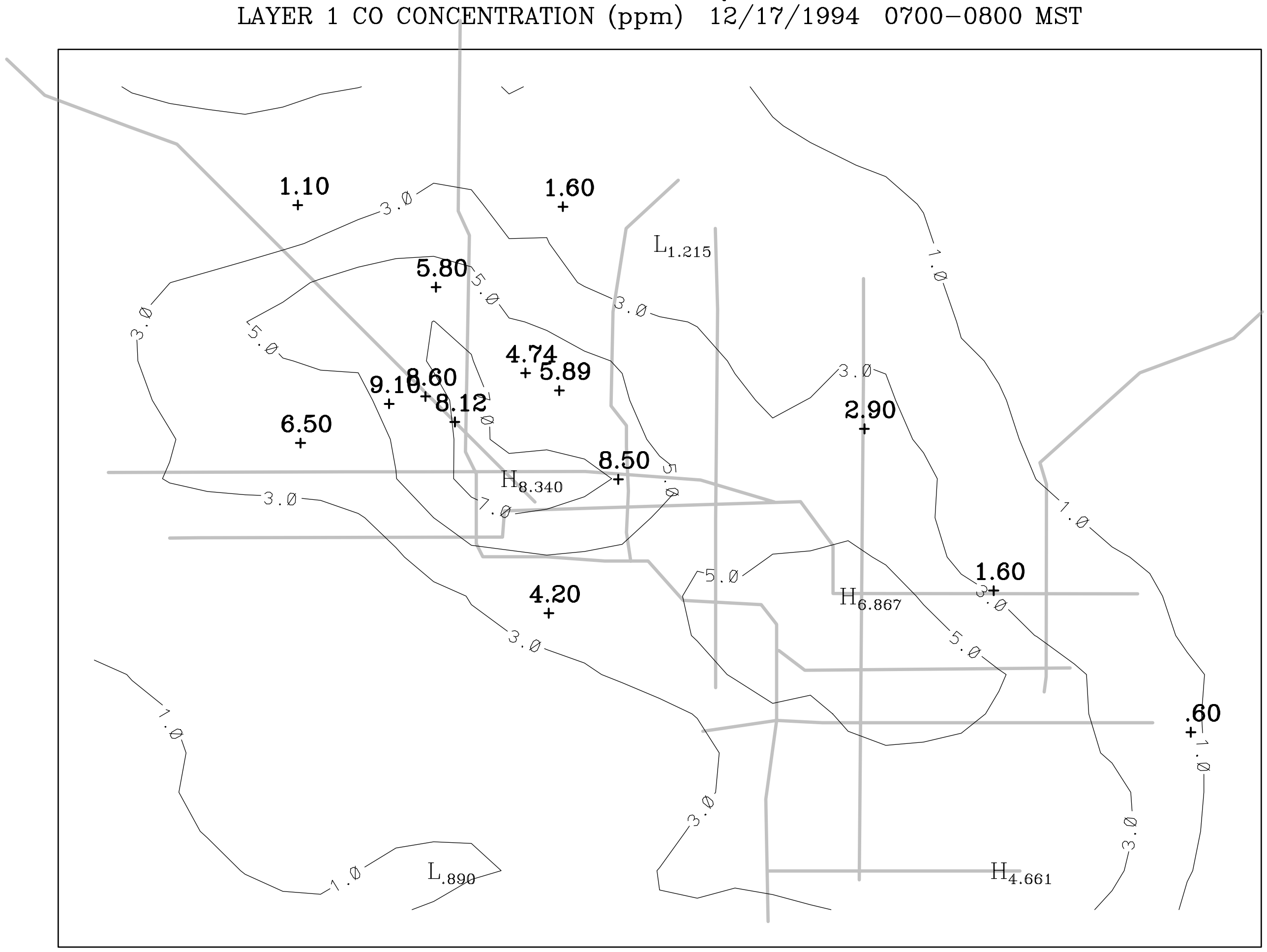
UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0600–0700 MST



SIMULATED MAX 9.06 MIN .48 AVG 2.79 MAX AT (14,13)
OBSERVED MAX 9.30 MIN .80 AVG 5.07

UAM + CAL3QHC

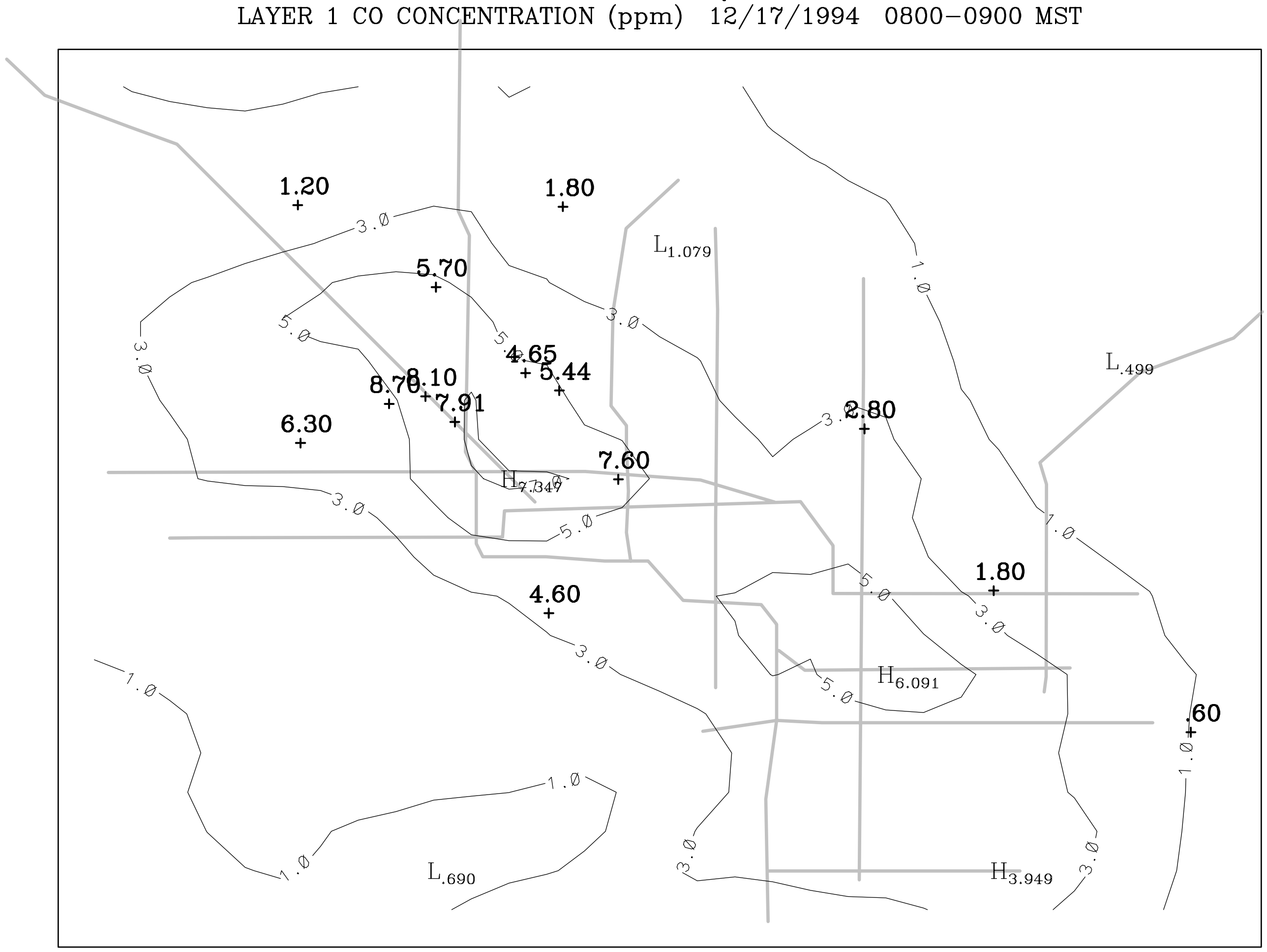
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0700−0800 MST



SIMULATED MAX 8.34 MIN .48 AVG 2.55 MAX AT (13,13)

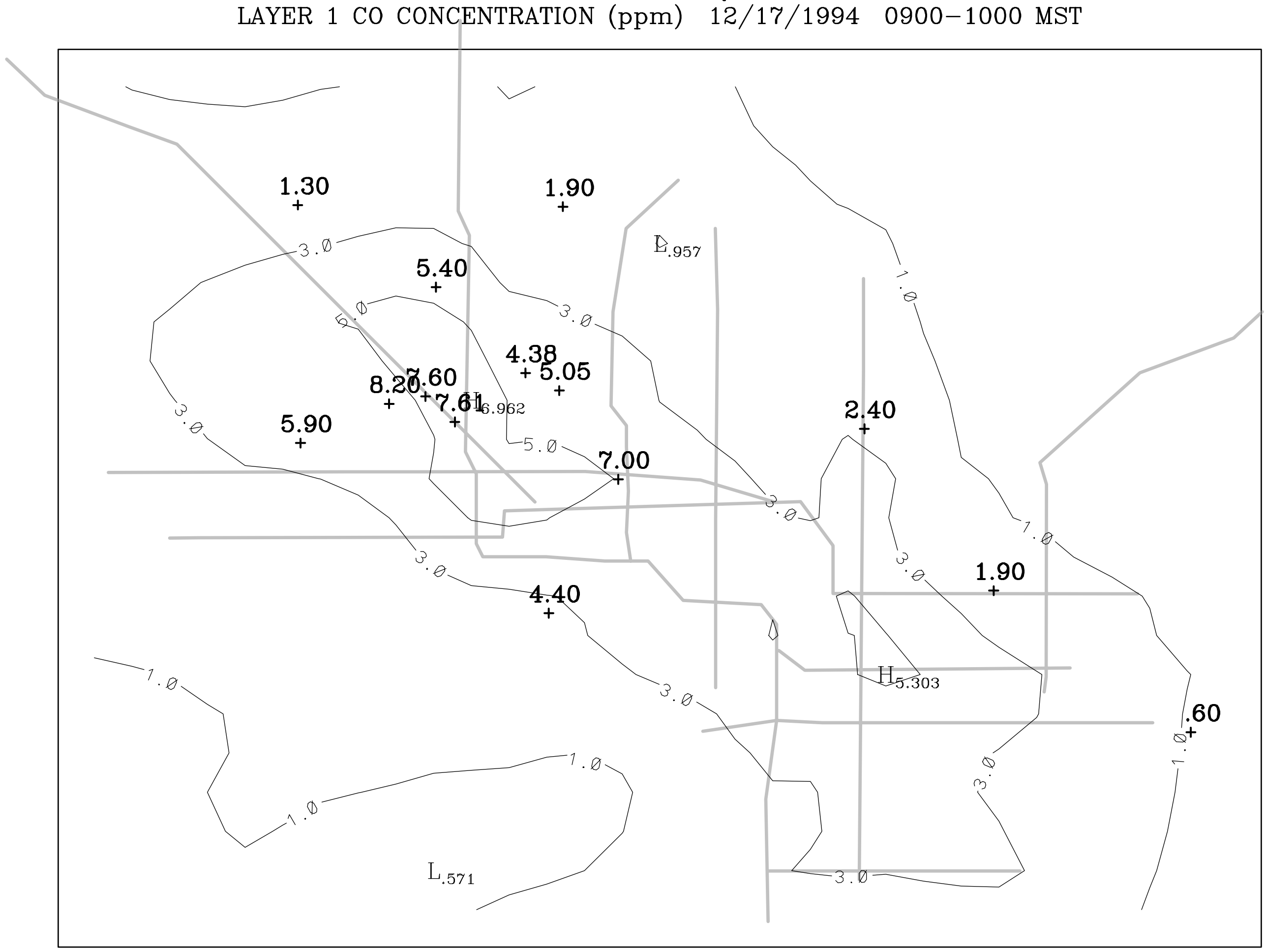
OBSERVED MAX 9.10 MIN .60 AVG 4.95

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0800–0900 MST



SIMULATED MAX 7.35 MIN .49 AVG 2.28 MAX AT (13,13)
OBSERVED MAX 8.70 MIN .60 AVG 4.80

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 0900–1000 MST

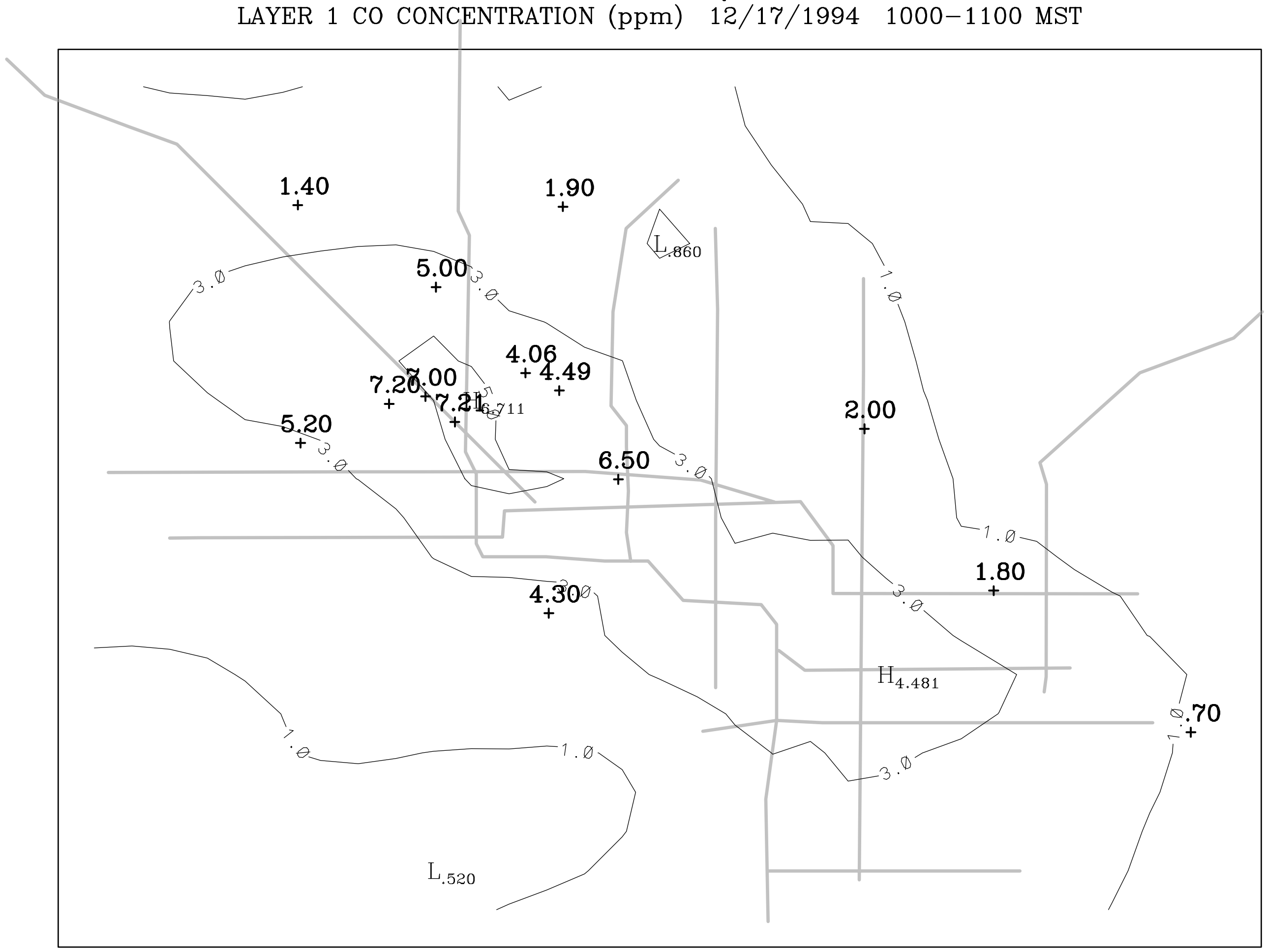


SIMULATED MAX 6.96 MIN .49 AVG 2.03

OBSERVED MAX 8.20 MIN .60 AVG 4.55

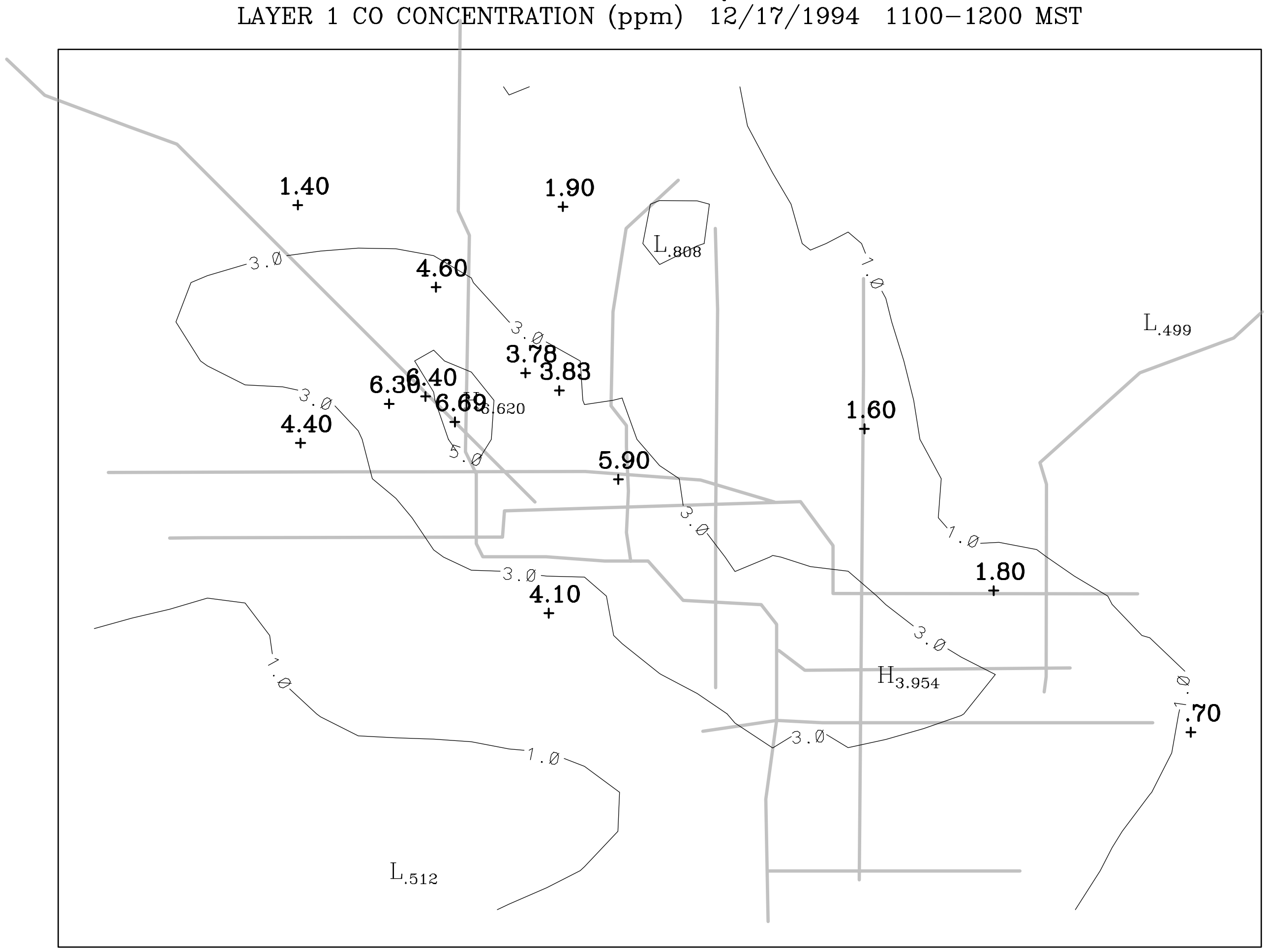
MAX AT (12,15)

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 1000–1100 MST



SIMULATED MAX 6.71 MIN .49 AVG 1.80 MAX AT (12,15)
OBSERVED MAX 7.21 MIN .70 AVG 4.20

UAM + CAL3QHC
LAYER 1 CO CONCENTRATION (ppm) 12/17/1994 1100–1200 MST



SIMULATED MAX 6.62 MIN .50 AVG 1.68 MAX AT (12,15)
OBSERVED MAX 6.69 MIN .70 AVG 3.81

Appendix IV-iv

Response to ADEQ Comments

App.IV-iv contains a letter from Arizona Department of Environmental Quality (ADEQ) dated November 7, 2002 regarding comments on the carbon monoxide urban and microscale simulations. Following the ADEQ letter is a letter from MAG responding to the general and specific comments from ADEQ.

Jane Dee Hull
Governor

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
(602) 771-2300 • www.adeq.state.az.us

Jacqueline E. Schafer
Director

AQD: AAS:EVAL:PGH:094-10-31-02

NOV 0 8 2002

November 7, 2002

Ruey-in Chiou, Air Quality Modeling Program Manager
Maricopa Association of Governments
302 North 1st Avenue, Suite 300
Phoenix, Arizona 85003

Dear Ms. Chiou:

Re: Maricopa Association of Governments (MAG) "Draft Technical Support Document for Carbon Monoxide Modeling in Support of the MAG 2002 Carbon Monoxide Maintenance Plan for the Maricopa County Nonattainment Area", September 2002

Thank you for the opportunity to comment on the carbon monoxide maintenance plan. The plan embodies sound, excellent technical work. The following comments should be interpreted as general suggestions for an improved analysis, but certainly do not necessitate additional model runs.

General:

The carbon monoxide design date of December 16-17, 1994 has presented considerable difficulties in previous attempts to accurately simulate the spatial distribution of elevated carbon monoxide concentrations. In the present reincarnation, the difficulties remain unsolved. Fortunately, for all concerned, the shortcomings of the simulation do not critically weaken the net results. On the positive side, the high 8-hour CO concentrations at the two peak sites, West Indian School Road and Thomas/Grand Avenue, were handled quite well. In contrast to the good agreement between simulations and observations there, however, the model substantially over predicts CO concentrations at points east and north of this peak area, and it under predicts in neighborhoods to the west. For example, over predictions at North Phoenix, Supersite, and the Post Office – all east and north of the peak area– vary from 100 to 217%, 22 to 49%, and 16 to 18%, respectively, for the hours of 0300 to 0800 of December 17. In the peak area, agreement at the two sites is quite good. But, then moving southwest a short distance to the neighborhood scale monitor of West Phoenix, the model under predicts CO by 25 to 31%; and, moving further west to Maryvale, the under predictions are slightly worse, at 30 to 35%. Mean domain wind speeds were all under 1.5 meters per second, with most being under 1.0 meters per second. Winds this light have highly variable directions, so perhaps the hourly resolution of the modeled winds cannot simulate the real-world variability of directions that result in the actual CO concentrations. Nonetheless, the fairly large areas of over and under predictions would suggest that there is something systematically different between the spatial distribution of CO emissions and the wind field in the model versus the real world.

Alternatively, and there are no data to explore this hypothesis, this over/under prediction could arise from a real-world spatially varying mixing height not accounted for in the model. If the strength of the temperature inversion is less in the areas of over prediction and greater in the areas of under prediction, because of differential land use or urban heat island effects, then that would account for the model's performance.

Specific:

p. III-3: M6Link and vehicle classes

The division of link-based traffic into four vehicle classes – light-duty commercial, medium duty commercial, heavy-duty commercial, and all others – is a welcome addition to traffic modeling, since it allows the assignation of vehicle-class-specific emission factors to the traffic on a link. In earlier work, only a single average emission factor representing the vehicular fleet as a whole could be assigned to a traffic volume on a link. It would be interesting to test how much difference this addition makes to the spatial distribution of on-road emissions in metropolitan Phoenix.

p. III-4: cold start emissions

The authors state that it would be "unlikely that vehicles would produce cold start emissions while on a freeway since it would generally take several minutes to reach a freeway from where the vehicle had been at rest."

While freeway traffic has a much lower proportion of cold start emissions than do local or arterials, the Federal Test Procedure defines cold start as the first 505 seconds of the driving cycle of a vehicle that has been at rest. This time of cold-start, although somewhat arbitrary, still drives the emissions models such as MOBILE6. Imagine, then, the entire vehicular fleet that begins a morning home-based work trip that progresses from local, to arterial, to freeway. Surely some significant proportion of this fleet would reach a freeway in less time than the 8.4 minutes of cold start. (On a personal note, it takes one author 30 to 40 seconds to reach a freeway from his home.) In the afternoon, leaving the place of employment to return home, an even higher proportion of the fleet would still be in cold start upon reaching the freeway, since places of employment tend to close to the freeways. Some additional sensitivity analyses could be undertaken to determine the fraction of freeway VMT in cold start, and, if necessary, future modeling should account for this. Allocating some of the cold-start VMT to freeways might result in slightly lower CO emissions, since the speeds would be higher.

p. III-11: mixing heights

In this thorough and excellent discussion, the authors explain the dynamics of the planetary boundary layer, the calculations of the mixing height values, and how the Urban Airshed Model simulates vertical air movement between the two layers. The inherent difficulties in the methods behind this somewhat artificial construct of "mixing height" are apparent. The difficulty and undefinable inaccuracies of the mixing height model suggest that a more reasonable approach might be to apply a mesoscale meteorological model to the simulation. In these models, vertical air movement is described on a cell by cell basis in terms of calculated eddy diffusivity coefficients. These coefficients are "translated" directly into the air quality model to produce vertical advection. To our knowledge, no one has tried to simulate CO in Phoenix with these more advanced tools, and it would be interesting to try this approach on this particular design date. Whether improved performance would be forthcoming is an open question.

p VII-49-50: Emission and concentration changes from 1994 to 2015

The authors present emissions and concentrations changes between 1994 and 2015 but do not discuss their findings in much detail. The predicted CO concentration in 2015 is 25.0% lower than in 1994 (8.65 ppm vs. 11.52 ppm). And yet CO emissions are only 14.1% lower (emission figures are for December 16). This discrepancy might be explained by noting that the on-road CO emissions decrease by 23.8% (the point, area, and non-road, as a whole, increase 33%). One way to shed some light on this would be through a sensitivity analysis in which the point, area, and non-road emissions were zeroed out. This analysis then might show what fraction of the predicted peak concentration comes from what source sector. If this analysis showed that these other emissions contributed a very small percentage to the peak CO concentration, then the mismatch between the emission and concentration decreases would be cleared up.

p VI-4 and VII-55: Peak regional versus hotspot CO concentrations

In both tables, showing the base case and 2015 predicted maximum CO concentrations, the highest predicted concentration is a regional one for a specific grid square. None of the grid squares including a hot spot intersection, where the predicted concentration is the sum of the regional and hot spot concentrations, had a concentration as high. These regional (grid-squre) predicted highs were about 10% higher than the highest hot spot/grid square concentration. Consider what concentrations would have been predicted had the spatial distribution of CO concentrations been slightly different. In both the base year and 2015, the grid with the predicted maximum was fairly close to the hot spot intersection with the highest hot spot concentrations (4.5 miles in the base; 3.6 miles in 2015). Had the model predicted its maximum in the hot spot grid, then the CO concentrations would have been 13.53 in the base case and 10.46 ppm for 2015. [Base case: 11.53 ppm for CO, maximum grid, plus 2.00 ppm maximum hot spot; for 2015, 8.65 ppm for CO, maximum grid, plus 1.81 ppm maximum hot spot.] A slight shift in the location of the predicted peak would have changed the outcome of the study. It might be prudent to consider such a possibility in light of the excellent discussion of model uncertainty on page VI-56.

p VI-4 and VII-55: Hotspot CO concentrations in the base year and 2015

The relative values for some receptor areas between the two years doesn't look right. See table below.

location	CAL3QHC [CO]	
	1994	2015
WISR monitor	0.06	0.03
WISR receptor #9	2.00	1.81
WISR receptor #10/#8	0.65	1.61
WISR receptor #21/#20	0.90	0.88
PHGA monitor	0.53	Na
PHGA receptor #76/#30	1.71	0.65
PHGA receptor #46/#46	1.46	0.20
PHGA receptor #74/#29	1.69	0.29

Some discussion, more than is given in the text, should be devoted to interpreting how traffic volume and roadway changes might lead to these figures, some of which are quite puzzling. For example, the WISR receptor #10 triples in value from 0.65 to 1.61 ppm, as receptor #8 in 2015. Two other WISR receptors do not show decreases consistent with the 24% decrease in on-road mobile CO emissions. The West Indian School Road receptors do not show the decrease from 1994 to 2015 that the Grand Avenue receptors do. Even if the Grand Avenue improvement is because of the flow-through interchange, unless there is a large increase in traffic volume, the hot spot concentrations at West Indian School ought to decrease along the lines of the overall metropolitan 25%. While the importance of this puzzle is minimal because the hot spot concentrations don't figure into the predicted peak concentrations, the report would be improved by explaining these changes in greater detail.

The Inspection and Maintenance input file containing the Stringency percentage for pre-1981 vehicles is set at 28%. The Vehicle Emissions and Inspections Section of Air Quality Division, ADEQ has determined a stringency rate of 40% for pre 1981 vehicles, although this was for the year 2000. The figure of 28% comes from the mid 1990s, appropriate for a 1994 design date. Changing this value would not affect the results much, since the MOBILE models are not very sensitive to this parameter, and because the percentage of pre-1981 vehicles for the set calendar year would be low.

Vehicle registration data used for this draft analysis are from 1997. More recent data from ADOT (2002) are now available and could have been used for the future year to reflect a more updated vehicle fleet. Whether the 2002 data would have provided a better estimate of 2015 vehicles, however, is an open question.

I trust that these comments have been constructive and would be happy to discuss any of them with you or your staff.

Sincerely,

Blyth for M. George

Mike George, Air Assessment Manager

cc Theresa Pella

MARICOPA
ASSOCIATION of
GOVERNMENTS

302 North 1st Avenue, Suite 300 ▲ Phoenix, Arizona 85003
Phone (602) 254-6300 ▲ FAX (602) 254-6490
Email: mag@mag.maricopa.gov ▲ Website: www.mag.maricopa.gov

November 26, 2002

Mr. Mike George, Manager
Air Assessment Section
Arizona Department of Environmental Quality
1110 W Washington Street
Phoenix, AZ 85007

Dear Mr. George:

Thank you for the letter of November 7, 2002. In your letter, you noted a number of comments on the ***Draft Technical Support Document for Carbon Monoxide Modeling in Support of the MAG 2002 Carbon Monoxide Maintenance Plan for the Maricopa County Nonattainment Area***. We appreciate your positive and constructive comments in improving the Technical Support Document. We are also pleased that your comments do not necessitate remodeling. Responses to your comments are presented below.

RESPONSE TO THE GENERAL COMMENTS

The Urban Airshed Model (UAM) normally tends to over predict at areas where low carbon monoxide (CO) concentrations were observed. The maximum CO concentrations observed at Glendale, Mesa, North Phoenix, South Scottsdale, and Gilbert ranged from 2 to 4.6 ppm. At certain hours when the CO concentrations were extremely low, a 2 ppm over-prediction in CO, for example, could be 100% or even 200% in error. According to the EPA Guidance, the model performance of the above monitoring sites was not included in the current study due to the 5.0 ppm cutoff value applied in the analyses. The primary purpose of the Carbon Monoxide Maintenance Plan is to show that the maximum CO concentration will not exceed the national standard by 2015 anywhere in the domain. Emphasis should not be placed at where and when the atmospheric CO is not of a health concern.

It is true, however, that the UAM simulated CO concentrations did not agree perfectly with the observed data everywhere in the domain. If time permits, additional sensitivity runs using different wind fields and mixing heights may be performed to further investigate the behavior of the simulated CO to changes in the inputs.

RESPONSE TO SPECIFIC COMMENTS

p. III-3: M6Link and vehicle classes

If time permits, the test suggested in your comment may be performed. An additional benefit to the division of the link-based traffic into these four vehicle classes is that each class has a distinct travel pattern both spatially and temporally, allowing for a better resolution of emissions by time and location.

p. III-4: cold start emissions

As indicated in your comment, freeway traffic has a much lower proportion of cold start emissions than local or arterial roads. Unfortunately, the exact relative amount of cold start emissions on the various roadway types was not available at the time of analysis. Given the choice of applying the cold start emissions equally on all facility types and reallocating cold start emissions that would have been placed on freeways to locals and arterials, the second option was chosen. The second method takes advantage of the MOBILE6 ability to separate out starting and running emissions and is considered a more accurate representation of real world conditions.

p. III-11: mixing heights

Additional spatially invariant or spatially variant diffusion break files may be generated using additional surface and upper-air observations if time permits. However, without sufficient observed data, it is hard to justify the accuracy of the simulated mixing heights and determine the "best" diffusion break for UAM. A prognostic model may be able to provide estimated mixing heights based on scientifically advanced theories. However, whether the estimated mixing heights are more accurate than those generated by the simpler models, for example, MIXEMUP, is left uncertain. Besides, UAM does not take eddy diffusivity coefficients directly as inputs. It will require a significant amount of time to apply a whole new modeling system which uses the eddy diffusivity coefficients for vertical advections in the CO Maintenance Plan. Although it will be interesting to perform the modeling work in different approaches, given the time constraint, the approach of using a different modeling system may not be possible this time.

p. VII-49-50: Emission and concentration changes from 1994 to 2015

The regional peak CO concentration does not respond to changes of the total emissions linearly as described in your comments. The emissions reduced from 1994 to 2015 may not happen homogeneously in both time and space. That is, some place in the modeling domain may have more than 25 % emission reduction and some place may have much less emission reduction when the overall reduction in emissions is 14.08% from 1994 to 2015. Besides, the peak CO was simulated at 4 A.M. and the contribution from the first a few hours of the second modeling day may be crucial to the peak CO.

The non-linear response of the regional peak CO to emission reductions can be further confirmed by the UAM sensitivity run that you suggested. Tables VII-8 and VII-9 in the CO TSD were combined and listed in the table below, together with the result from a UAM run testing the model sensitivity to emission changes. The UAM run used only onroad mobile source emissions and zeroed out emissions from all other source categories in 2015, as suggested in your comments. Comparison of this sensitivity run with the 1994 base case for the first day (Friday) shows that with 37% reduction in emissions, the CO concentration is 38% lower in 2015. If the comparison was made between the sensitivity run and the 2015 committed measure package case, the CO concentration is 17% lower with 26% reduction in emissions. Same comparison for the second day, 48% versus 38% and 40% versus 17% respectively, reveals that the non-linear relationship between emission reduction and CO concentration is even more obvious.

	source	1994	2015	change %	2015_sens1	change % vs. 1994	change % vs. 2015
Friday	point	2.50	32.20	1188.00	0.00	-100.00	-100.00
	area	21.00	36.20	72.38	0.00	-100.00	-100.00
	nonroad	155.10	169.90	9.54	0.00	-100.00	-100.00
	onroad	869.60	662.30	-23.84	662.30	-23.84	0.00
	total	1048.20	900.60	-14.08	662.30	-36.82	-26.46
	MAX CO	11.52	8.65	-24.91	7.14	-38.02	-17.46
Saturday	point	2.50	31.50	1160.00	0.00	-100.00	-100.00
	area	21.30	35.30	65.73	0.00	-100.00	-100.00
	nonroad	207.70	208.10	0.19	0.00	-100.00	-100.00
	onroad	538.10	397.60	-26.11	397.60	-26.11	0.00
	total	769.60	672.50	-12.62	397.60	-48.34	-40.88
	MAX CO	11.52	8.65	-24.91	7.14	-38.02	-17.46

Therefore, the present CO plan does not show any mismatch between the emission inventories and the CO concentrations.

p. VI-4 and VII-55: Peak regional versus hotspot CO concentrations

Hotspot intersections are chosen by MAG on the basis of level of service (average vehicle delay) and, on a secondary basis, proximity of air quality monitors with historic exceedences to traffic intersections. As indicated in Guideline for Modeling Carbon Monoxide from Roadway Intersections, EPA-454/R-92-005, "Intersections for analysis will be selected from those intersections whose conditions are suspected to be the most conducive to high concentration impacts."

The intersections chosen for inclusion in the hotspot analysis were chosen because the MAG transportation modeling networks indicate that these two intersections will be classified as level of service F in 2015, which reflects a delay of over 60 seconds per vehicle. Additionally, monitors with historically relatively higher carbon monoxide concentrations are situated very near to the intersections, enhancing the ability to validate modeling concentration data. If the UAM simulated the peak in the hot spot grid and resulted 13.53 ppm combined CO concentrations in 1994, the poor model performance (29% error in paired peak comparison) indicates that the model inputs may need to be examined for quality assurance. MAG staff followed the quality assurance and diagnostic procedures specified in the Protocol to make sure that the models perform well with quality assured inputs.

p. VI-4 and VII-55: Hotspot CO concentrations in the base year and 2015 *p. VI-4 and VII-55: Hotspot CO concentrations in the base year and 2015*

The microscale concentrations at both hot spots, Grand Avenue and West Indian School Road, do show decreases from 1994 to 2015 if the comparison was made to the corresponding hours in both years. A portion of the table in your letter was reproduced below with the hours the data reflect added in.

Location	CAL3QHC [CO]	
	1994	2015
WISR monitor	0.06	0.03
WISR receptor #9	2.00 (2 a.m.)	1.81 (2 a.m.)
WISR receptor #10/#8	0.65 (4 a.m.)	1.61 (2 a.m.)
WISR receptor #21/#20	0.90 (3 a.m.)	0.88 (3 a.m.)

Note that the 0.65 ppm at the receptor #10 occurred at 4 a.m. in the 1994 episode and the 1.61 ppm at the receptor #8 occurred at 2 a.m. in the 2015 episode. The receptors listed in Tables VI-1 and VII-11 were due to their high rankings of the combined microscale and UAM concentrations, not based solely upon the microscale concentrations. If the comparison was based upon the microscale concentrations only, the CO concentrations decrease consistently from 1994 to 2015 for all receptors at corresponding hours.

You also commented about the stringency percentage applied in the Inspection and Maintenance input file for MOBILE6. As indicated, the value of 28 percent is appropriate for use in the 1994 episode day. MOBILE6 models emission factors for the most recent 25 model years. Since the maintenance year analysis reflects December 2015 (modeled as January 2016), model year vehicles before model year 1992 are not considered. As such, the stringency rate percentage, which only affects model years older than 1981, has no affect on the 2015 maintenance year analysis.

Vehicle registration data used for the 1994 analysis reflect 1997 ADOT data because the 1997 data was closer to the 1994 time period being analyzed. However, the 2015 maintenance year scenario reflects the newer 1999 rather than 1997 ADOT data. The modeling work in support of the CO Maintenance Plan began in early 2002 when the 2002 registration data were not yet made available from ADOT.

We enjoyed the in-depth discussions with you. Should you need further information, please feel free to contact me.

Sincerely,

Ruey-in Chiou
Air Quality Modeling Program Manager

cc: Peter Hyde, ADEQ
Theresa Pella, ADEQ

APPENDIX V

MICROSCALE INTERSECTION MODELING

APPENDIX V-i

Sample Mobile6 Files

App.V-i contains information on the microscale intersection modeling. Included in Appendix V-i are a portion of the MOBILE6 files used to estimate emission factors input to the CAL3QHC model.

Pages V-3 and V-4 reflect the MOBILE6 input that include the I/M program and pages V-5 and V-6 reflect the MOBILE6 input without the I/M program. Pages V-7 and V-8 reflect MOBILE6 output that include the I/M program and pages V-9 and V-10 reflect the MOBILE6 output without the I/M program.

The MOBILE6 inputs used for the microscale analysis differ from those used as input to M6Link in that the speeds reflect estimated speeds for the specific roadway portions being modeled rather than the speed outputs from the EMME/2 program. Also, the method of inputting hourly temperature data is different in the runs performed to estimate factors for use in CAL3QHC because aggregate emission factors are required on an hourly basis for input to CAL3QHC.

```
OBILE6 INPUT FILE :
POLLUTANTS         : CO


RUN DATA
EXPAND EXHAUST     :
STARTS PER DAY     : STPERDAY.zer
I/M PROGRAM        : 1 1977 2050 1 T/O LOADED/IDLE
I/M MODEL YEARS    : 1 1967 2050
I/M VEHICLES       : 1 11111 22222222 2
I/M STRINGENCY     : 1 28.0
I/M COMPLIANCE     : 1 97.0
I/M WAIVER RATES   : 1 1.3 1.0
I/M GRACE PERIOD   : 1 5
I/M PROGRAM        : 2 1977 2050 2 T/O IM240
I/M MODEL YEARS    : 2 1981 1995
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 28.0
I/M COMPLIANCE     : 2 97.0
I/M WAIVER RATES   : 2 1.3 1.0
I/M GRACE PERIOD   : 2 5
I/M CUTPOINTS      : 2 CUTPNT15.d
I/M PROGRAM        : 3 1977 2050 1 T/O LOADED/IDLE
I/M MODEL YEARS    : 3 1967 1980
I/M VEHICLES       : 3 22222 11111111 1
I/M STRINGENCY     : 3 28.0
I/M COMPLIANCE     : 3 97.0
I/M WAIVER RATES   : 3 1.3 1.0
I/M PROGRAM        : 4 2001 2050 2 T/O OBD I/M
I/M MODEL YEARS    : 4 1996 2050
I/M VEHICLES       : 4 22222 11111111 1
I/M STRINGENCY     : 4 28.0
I/M COMPLIANCE     : 4 97.0
I/M WAIVER RATES   : 4 1.3 1.0
I/M GRACE PERIOD   : 4 5
I/M PROGRAM        : 5 2001 2050 2 T/O EVAP OBD & GC
I/M MODEL YEARS    : 5 1996 2050
I/M VEHICLES       : 5 22222 11111111 1
I/M STRINGENCY     : 5 28.0
I/M COMPLIANCE     : 5 97.0
I/M WAIVER RATES   : 5 1.3 1.0
I/M GRACE PERIOD   : 5 5

ANTI-TAMP PROG     :
87 75 80 22222 22222222 2 11 097. 22111222
ANTI-TAMP PROG     :
87 81 95 11111 22222222 2 11 097. 22111222

*the tech12.d file must be located with Mobile6 execution file
*the user tech file tech12.1me should be renamed as tech12.d
*Two more I/M programs should not have overlapped motor vehicles.

REG DIST           : tjreg.d
DIESEL FRACTIONS   :
0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020
0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0040 0.0030
0.0030 0.0030 0.0020 0.0020 0.0030
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.0290 0.0550
0.0470 0.0360 0.0240 0.0390 0.0310
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.0290 0.0550
0.0470 0.0360 0.0240 0.0390 0.0310
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
```

```
0.0126 0.0115 0.0111 0.0145 0.0115
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0115 0.0111 0.0145 0.0115
0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998
0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998
0.1998 0.2578 0.2515 0.3263 0.2784
0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774
0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774
0.6774 0.7715 0.7910 0.8105 0.8068
0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606
0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606
0.8606 0.8473 0.8048 0.8331 0.7901
0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647
0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647
0.4647 0.4384 0.3670 0.4125 0.3462
0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300
0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300
0.6300 0.6078 0.5246 0.5767 0.5289
0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563
0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563
0.8563 0.8443 0.7943 0.8266 0.7972
0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992
0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992
0.9992 0.9989 0.9987 0.9989 0.9977
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000
0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585
0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585
0.9585 0.8857 0.8525 0.8795 0.9900

SCENARIO RECORD    : Noon - idle
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 2.5  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

SCENARIO RECORD    : Noon - 25 mph
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 25.  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

MOBILE6 INPUT FILE :
POLLUTANTS         : CO
```

```
RUN DATA
EXPAND EXHAUST     :
STARTS PER DAY     : STPERDAY.zer

REG DIST           : tjreg.d
DIESEL FRACTIONS   :
0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020
0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0040 0.0030
0.0030 0.0030 0.0020 0.0020 0.0030
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.0290 0.0550
0.0470 0.0360 0.0240 0.0390 0.0310
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.0290 0.0550
0.0470 0.0360 0.0240 0.0390 0.0310
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0115 0.0111 0.0145 0.0115
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126
0.0126 0.0115 0.0111 0.0145 0.0115
0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998
0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998
0.1998 0.2578 0.2515 0.3263 0.2784
0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774
0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774
0.6774 0.7715 0.7910 0.8105 0.8068
0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606
0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606
0.8606 0.8473 0.8048 0.8331 0.7901
0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647
0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647
0.4647 0.4384 0.3670 0.4125 0.3462
0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300
0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300
0.6300 0.6078 0.5246 0.5767 0.5289
0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563
0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563
0.8563 0.8443 0.7943 0.8266 0.7972
0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992
0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992
0.9992 0.9989 0.9987 0.9989 0.9977
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000
0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585
0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585
0.9585 0.8857 0.8525 0.8795 0.9900

SCENARIO RECORD    : Noon - idle
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 2.5  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

SCENARIO RECORD    : Noon - 25 mph
```

```
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 25.  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

SCENARIO RECORD    : Noon - 30 mph
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 30.  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

SCENARIO RECORD    : Noon - 35 mph
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
AVERAGE SPEED      : 35.  Arterial
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

SCENARIO RECORD    : Noon - 40 mph
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
MIN/MAX TEMPERATURE: 61.8   61.8
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Noon - idle
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
  M583 Warning:
            The user supplied arterial average speed of  2.5
            will be used for all hours of the day.  100% of VMT
            has been assigned to the arterial/collector roadway
            type for all hours of the day and all vehicle types.
  M616 Comment:
               User has supplied post-1999 sulfur levels.

          User supplied gasoline sulfur content =  30.0 ppm.

*** I/M credits for Tech1&2 vehicles were read from the following external
    data file: TECH12.D
  M 48 Warning:
              there are no sales for vehicle class HDGV8b

                    Calendar Year:  2016
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  61.8 (F)
              Maximum Temperature:  61.8 (F)
                Absolute Humidity:   75. grains/lb
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   9.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

   Ether Blend Market Share: 0.000       Alcohol Blend Market Share: 1.000
   Ether Blend Oxygen Content: 0.000     Alcohol Blend Oxygen Content: 0.035
                                          Alcohol Blend RVP Waiver: No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT      HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ------    ------    ------
   VMT Distribution:    0.2957    0.3213    0.1523              0.0362    0.0006    0.0949    0.0949    0.0040    1.0000
  ------------------------------------------------------------------------------------------------------------------------
 Composite Emission Factors (g/mi):
     Composite CO  :     12.41     14.52     17.05     15.34     28.87     2.311     1.296     2.817     79.34    12.687
```

```
 ------------------------------------------------------------------------------------------------------------------------
Exhaust emissions (g/mi):

          CO Start:      0.00      0.00      0.00      0.00                0.000     0.000                0.000
        CO Running:     12.41     14.52     17.05     15.34                2.311     1.296               79.342
   CO Total Exhaust:     12.41     14.52     17.05     15.34     28.87     2.311     1.296     2.817     79.34    12.687
 ------------------------------------------------------------------------------------------------------------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Noon - 25 mph
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
  M583 Warning:
            The user supplied arterial average speed of 25.0
            will be used for all hours of the day.  100% of VMT
            has been assigned to the arterial/collector roadway
            type for all hours of the day and all vehicle types.
  M616 Comment:
               User has supplied post-1999 sulfur levels.

          User supplied gasoline sulfur content =  30.0 ppm.

  M 48 Warning:
              there are no sales for vehicle class HDGV8b

                    Calendar Year:  2016
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  61.8 (F)
              Maximum Temperature:  61.8 (F)
                Absolute Humidity:   75. grains/lb
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   9.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
```

```
***************************************************************************
* MOBILE6 (16-Jan-2002)                                                   *
* Input file: NIM15MIC.IN (file 1, run 1).                                *
***************************************************************************

* Reading start Starts/day distribution from the following external
* data file: STPERDAY.ZER

* Reading Registration Distributions from the following external
* data file: TJREG.D
  M 49 Warning:
                0.999     MYR sum not = 1. (will normalize)
  M 49 Warning:
                0.999     MYR sum not = 1. (will normalize)
  M 49 Warning:
                0.999     MYR sum not = 1. (will normalize)
  M 49 Warning:
                0.999     MYR sum not = 1. (will normalize)
  M 49 Warning:
                 1.00     MYR sum not = 1. (will normalize)
  M 49 Warning:
                0.998     MYR sum not = 1. (will normalize)
  M614 Comment:
               User supplied diesel sale fractions.

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Noon - idle
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #

* A user supplied arterial average speed of  2.5 will
* be used for all hours of the day.  100% of VMT has been
* assigned to the arterial/collector roadway type for all
* hours of the day and all vehicle types.

  M616 Comment:
               User has supplied post-1999 sulfur levels.

          User supplied gasoline sulfur content =  30.0 ppm.

  M 48 Warning:
              there are no sales for vehicle class HDGV8b
```

```
                 Calendar Year:  2016
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  61.8 (F)
           Maximum Temperature:  61.8 (F)
             Absolute Humidity:   75. grains/lb
              Nominal Fuel RVP:   9.0 psi
                 Weathered RVP:   9.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  No
             Reformulated Gas:  No

  Ether Blend Market Share: 0.000       Alcohol Blend Market Share: 1.000
  Ether Blend Oxygen Content: 0.000     Alcohol Blend Oxygen Content: 0.035
                                         Alcohol Blend RVP Waiver: No
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT      HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ------    ------    ------
  VMT Distribution:    0.2957    0.3213    0.1523              0.0362    0.0006    0.0949    0.0949    0.0040    1.0000
 ----------------------------------------------------------------------------------------------------------------------
 Composite Emission Factors (g/mi):
     Composite CO  :    18.66     20.03     23.44     21.13     31.54     2.311     1.296     2.817     79.34    17.377
 ----------------------------------------------------------------------------------------------------------------------
Exhaust emissions (g/mi):

          CO Start:      0.00      0.00      0.00      0.00               0.000     0.000               0.000
        CO Running:     18.66     20.03     23.44     21.13               2.311     1.296              79.342
  CO Total Exhaust:     18.66     20.03     23.44     21.13     31.54     2.311     1.296     2.817     79.34    17.377
 ----------------------------------------------------------------------------------------------------------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Noon - 25 mph
* File 1, Run 1, Scenario 2.
```

APPENDIX V-ii

Sample CAL3QHC Files

App.V-ii contains information on the microscale intersection modeling. Included in Appendix V-ii are a sample CAL3QHC input file and the associated CAL3QHC output file.

Pages V-12 through V-13 contain a sample CAL3QHC input file. Pages V-14 through V-18 reflect the output for the same CAL3QHC run.

It is important to note that each CAL3QHC run estimates one-hour carbon monoxide concentrations. These one-hour concentrations are later merged together to create eight-hour average concentration estimates.

```
THOMAS AND GRAND INTERSECTION            60.175.   0. 0.  60    0.3048
REC 61                   -200.      600.      6.0
REC 62                    -75.      600.      6.0
REC 63                    -75.      425.      6.0
REC 64                   -100.      400.      6.0
REC 65                    -75.      400.      6.0
REC 66                   -150.      250.      6.0
REC 67                   -400.      200.      6.0
REC 68                   -200.      200.      6.0
REC 69                   -100.      200.      6.0
REC 70                    -75.      175.      6.0
REC 71                   -150.      150.      6.0
REC 72                   -100.      150.      6.0
REC 73                    -75.      125.      6.0
REC 74                   -200.      100.      6.0
REC 75                   -100.      100.      6.0
REC 76                    -50.      100.      6.0
REC 77                   -125.       75.      6.0
REC 78                    -75.       75.      6.0
REC 79                    -50.       75.      6.0
REC 80                   -600.       50.      6.0
REC 81                   -400.       50.      6.0
REC 82                   -350.       50.      6.0
REC 83                   -300.       50.      6.0
REC 84                   -250.       50.      6.0
REC 85                   -200.       50.      6.0
REC 86                   -150.       50.      6.0
REC 87                   -125.       50.      6.0
REC 88                   -100.       50.      6.0
REC 89                    -75.       50.      6.0
REC 90                    -50.       50.      6.0
REC 91                   -600.      -50.      6.0
REC 92                   -400.      -50.      6.0
REC 93                   -350.      -50.      6.0
REC 94                   -300.      -50.      6.0
REC 95                   -250.      -50.      6.0
REC 96                   -200.      -50.      6.0
REC 97                   -150.      -50.      6.0
REC 98                   -125.      -50.      6.0
REC 99                   -100.      -50.      6.0
REC100                    -75.      -50.      6.0
REC101                    -50.      -50.      6.0
REC102                   - 50.      -75.      6.0
REC103                   -250.     -100.      6.0
REC104                   -200.     -100.      6.0
REC105                   -150.     -100.      6.0
REC106                   -100.     -100.      6.0
REC107                    -50.     -100.      6.0
REC108                    -50.     -125.      6.0
REC109                   -150.     -150.      6.0
REC110                   -100.     -150.      6.0
REC111                    -50.     -150.      6.0
REC112                   -200.     -200.      6.0
REC113                   -100.     -200.      6.0
REC114                    -50.     -200.      6.0
REC115                   -100.     -250.      6.0
REC116                    -50.     -250.      6.0
REC117                    -50.     -300.      6.0
REC118                    -50.     -350.      6.0
REC119                    -50.     -400.      6.0
REC120                    -50.     -600.      6.0
2015 TMS Set A (1-60)          Hour:  24 28  1   0
  1
27NBFF              AG     20  -1000     20      0    355.  4.   0  54
  1
27NBD               AG     20      0      5   1000    240.  4.   0  44
  1
27SBFF              AG    -20   1000    -13      0    263.  4.   0  56
  1
27SBD               AG    -13      0    -20  -1000    269.  4.   0  43
  1
THEBFF              AG  -1000    -10      0    -10    258.  4.   0  56
  1
THEBD               AG      0    -10   1000     10    402.  4.   0  56
  1
THWBFF              AG   1000     40      0     20    458.  4.   0  56
  1
THWBD               AG      0     20  -1000     20    401.  4.   0  56
  1
GRSE1               BR  -1225   1200      0    188    370.  4.  15  56
  1
GRSE2               BR    325   -166      0    188    370.  4.  32  56
  1
GRSE3               BR    325   -166    581   -538    370.  4.  32  56
  1
GRSE4               AG    969  -1019    581   -538    393.  4.   0  56
```

```
  1
GRNW1               AG  -1188   1238      0    269    387.  4.   0  56
  1
GRNW2               BR      0    269    363   -119    387.  4.  15  56
  1
GRNW3               BR    363   -119    625   -506    387.  4.  32  56
  1
GRNW4               BR    625   -506   1006   -994    387.  4.  32  56
  1
ONR1                AG     31   -219    156   -188      2.  4.   0  32
  1
ONR2                AG     31    -56    156   -188     20.  4.   0  32
  1
ONR3                BR    513   -538    156   -188     22.  4.   8  32
  1
ONR4                BR    513   -538    581   -538     22.  4.  15  32
  2
27NBLQ              AG      2   -136      2  -1000    0     12   1
        90        78       4.0   59  98.13 2000 2 3
  2
27NBTQ              AG     20   -145     20  -1000    0     24   2
        90        61       4.0  137  98.13 2000 2 3
  2
27NBRQ              AG     38   -154     38  -1000    0     12   1
        90        61       4.0  159  98.13 2000 2 3
  2
27SBLQ              AG      3     98     -2   1000    0     12   1
        90        78       4.0   80  98.13 2000 2 3
  2
27SBTQ              AG    -15    107    -20   1000    0     24   2
        90        61       4.0  148  98.13 2000 2 3
  2
27SBRQ              AG    -33    116    -38   1000    0     12   1
        90        61       4.0   35  98.13 2000 2 3
  2
THEBQ               AG    -92    -15  -1000    -10    0     48   4
        90        41       4.0  258  98.13 2000 2 3
  2
THWBQ               AG     70     22   1000     40    0     48   4
        90        41       4.0  458  98.13 2000 2 3
 1.172.5   20.  0.N  0  0  0
```

JOB: THOMAS AND GRAND INTERSECTION   RUN: 2015 TMS Set A (1-60)   Hour: 24
DATE: 0000   TIME: 0000

SITE & METEOROLOGICAL VARIABLES

VS =   0.0 CM/S   VD =   0.0 CM/S   Z0 = 175. CM
U = 1.0 M/S   CLAS =   5 (E)   ATIM = 60. MINUTES   MIXH =   20. M   AMB = 0.0 PPM BRG = 172. DEGREES

LINK VARIABLES

LINK DESCRIPTION	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	LENGTH (M)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (M)	W (M)	V/C	QUEUE (VEH)
1. 27NBFF	6.1	-304.8	6.1	0.0	305.	360.	AG	355.	4.0	0.0	16.5		
2. 27NBD	6.1	0.0	1.5	304.8	305.	359.	AG	240.	4.0	0.0	13.4		
3. 27SBFF	-6.1	304.8	-4.0	0.0	305.	180.	AG	263.	4.0	0.0	17.1		
4. 27SBD	-4.0	0.0	-6.1	-304.8	305.	180.	AG	269.	4.0	0.0	13.1		
5. THEBFF	-304.8	-3.0	0.0	-3.0	305.	90.	AG	258.	4.0	0.0	17.1		
6. THEBD	0.0	-3.0	304.8	3.0	305.	89.	AG	402.	4.0	0.0	17.1		
7. THWBFF	304.8	12.2	0.0	6.1	305.	269.	AG	458.	4.0	0.0	17.1		
8. THWBD	0.0	6.1	-304.8	6.1	305.	270.	AG	401.	4.0	0.0	17.1		
9. GRSE1	-373.4	365.8	0.0	57.3	484.	130.	BR	370.	4.0	4.6	17.1		
10. GRSE2	99.1	-50.6	0.0	57.3	146.	317.	BR	370.	4.0	9.8	17.1		
11. GRSE3	99.1	-50.6	177.1	-164.0	138.	145.	BR	370.	4.0	9.8	17.1		
12. GRSE4	295.4	-310.6	177.1	-164.0	188.	321.	AG	393.	4.0	0.0	17.1		
13. GRNW1	-362.1	377.3	0.0	82.0	467.	129.	AG	387.	4.0	0.0	17.1		
14. GRNW2	0.0	82.0	110.6	-36.3	162.	137.	BR	387.	4.0	4.6	17.1		
15. GRNW3	110.6	-36.3	190.5	-154.2	142.	146.	BR	387.	4.0	9.8	17.1		
16. GRNW4	190.5	-154.2	306.6	-303.0	189.	142.	BR	387.	4.0	9.8	17.1		
17. ONR1	9.4	-66.8	47.5	-57.3	39.	76.	AG	2.	4.0	0.0	9.8		
18. ONR2	9.4	-17.1	47.5	-57.3	55.	137.	AG	20.	4.0	0.0	9.8		
19. ONR3	156.4	-164.0	47.5	-57.3	152.	314.	BR	22.	4.0	2.4	9.8		
20. ONR4	156.4	-164.0	177.1	-164.0	21.	90.	BR	22.	4.0	4.6	9.8		
21. 27NBLQ	0.6	-41.5	0.6	-49.1	8.	180.	AG	228.	100.0	0.0	3.7	0.44	1.3
22. 27NBTQ	6.1	-44.2	6.1	-51.1	7.	180.	AG	357.	100.0	0.0	7.3	0.13	1.2
23. 27NBRQ	11.6	-46.9	11.6	-63.1	16.	180.	AG	178.	100.0	0.0	3.7	0.31	2.7
24. 27SBLQ	0.9	29.9	0.9	40.3	10.	360.	AG	228.	100.0	0.0	3.7	0.60	1.7
25. 27SBTQ	-4.6	32.6	-4.6	40.1	8.	360.	AG	357.	100.0	0.0	7.3	0.14	1.3
26. 27SBRQ	-10.1	35.4	-10.1	38.9	4.	360.	AG	178.	100.0	0.0	3.7	0.07	0.6
27. THEBQ	-28.0	-4.6	-32.4	-4.5	4.	270.	AG	480.	100.0	0.0	14.6	0.07	0.7
28. THWBQ	21.3	6.7	29.1	6.9	8.	89.	AG	480.	100.0	0.0	14.6	0.12	1.3

JOB: THOMAS AND GRAND INTERSECTION   RUN: 2015 TMS Set A (1-60)   Hour: 24
DATE: 0000   TIME: 0000

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
21. 27NBLQ	90	78	4.0	59	2000	98.13	2	3
22. 27NBTQ	90	61	4.0	137	2000	98.13	2	3
23. 27NBRQ	90	61	4.0	159	2000	98.13	2	3
24. 27SBLQ	90	78	4.0	80	2000	98.13	2	3
25. 27SBTQ	90	61	4.0	148	2000	98.13	2	3
26. 27SBRQ	90	61	4.0	35	2000	98.13	2	3
27. THEBQ	90	41	4.0	258	2000	98.13	2	3
28. THWBQ	90	41	4.0	458	2000	98.13	2	3

RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (M) X	Y	Z
1. REC 61	-61.0	182.9	1.8
2. REC 62	-22.9	182.9	1.8
3. REC 63	-22.9	129.5	1.8
4. REC 64	-30.5	121.9	1.8
5. REC 65	-22.9	121.9	1.8
6. REC 66	-45.7	76.2	1.8
7. REC 67	-121.9	61.0	1.8
8. REC 68	-61.0	61.0	1.8
9. REC 69	-30.5	61.0	1.8
10. REC 70	-22.9	53.3	1.8
11. REC 71	-45.7	45.7	1.8
12. REC 72	-30.5	45.7	1.8
13. REC 73	-22.9	38.1	1.8
14. REC 74	-61.0	30.5	1.8
15. REC 75	-30.5	30.5	1.8
16. REC 76	-15.2	30.5	1.8
17. REC 77	-38.1	22.9	1.8
18. REC 78	-22.9	22.9	1.8
19. REC 79	-15.2	22.9	1.8
20. REC 80	-182.9	15.2	1.8
21. REC 81	-121.9	15.2	1.8
22. REC 82	-106.7	15.2	1.8
23. REC 83	-91.4	15.2	1.8
24. REC 84	-76.2	15.2	1.8
25. REC 85	-61.0	15.2	1.8
26. REC 86	-45.7	15.2	1.8
27. REC 87	-38.1	15.2	1.8
28. REC 88	-30.5	15.2	1.8
29. REC 89	-22.9	15.2	1.8

30. REC 90	*	-15.2	15.2	1.8 *
31. REC 91	*	-182.9	-15.2	1.8 *
32. REC 92	*	-121.9	-15.2	1.8 *
33. REC 93	*	-106.7	-15.2	1.8 *
34. REC 94	*	-91.4	-15.2	1.8 *
35. REC 95	*	-76.2	-15.2	1.8 *
36. REC 96	*	-61.0	-15.2	1.8 *
37. REC 97	*	-45.7	-15.2	1.8 *

1

JOB: THOMAS AND GRAND INTERSECTION RUN: 2015 TMS Set A (1-60) Hour: 24

DATE: 0000 TIME: 0000

RECEPTOR LOCATIONS

RECEPTOR	* COORDINATES (M) X	Y	Z *
38. REC 98	-38.1	-15.2	1.8
39. REC 99	-30.5	-15.2	1.8
40. REC100	-22.9	-15.2	1.8
41. REC101	-15.2	-15.2	1.8
42. REC102	-15.2	-22.9	1.8
43. REC103	-76.2	-30.5	1.8
44. REC104	-61.0	-30.5	1.8
45. REC105	-45.7	-30.5	1.8
46. REC106	-30.5	-30.5	1.8
47. REC107	-15.2	-30.5	1.8
48. REC108	-15.2	-38.1	1.8
49. REC109	-45.7	-45.7	1.8
50. REC110	-30.5	-45.7	1.8
51. REC111	-15.2	-45.7	1.8
52. REC112	-61.0	-61.0	1.8
53. REC113	-30.5	-61.0	1.8
54. REC114	-15.2	-61.0	1.8
55. REC115	-30.5	-76.2	1.8
56. REC116	-15.2	-76.2	1.8
57. REC117	-15.2	-91.4	1.8
58. REC118	-15.2	-106.7	1.8
59. REC119	-15.2	-121.9	1.8
60. REC120	-15.2	-182.9	1.8

MODEL RESULTS

REMARKS : In search of the angle corresponding to
the maximum concentration, only the first
angle, of the angles with same maximum

```
                concentrations, is indicated as maximum.

 WIND  * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC1  REC2  REC3  REC4  REC5  REC6  REC7  REC8  REC9  REC10 REC11 REC12 REC13 REC14 REC15 REC16 REC17 REC18 REC19 REC20
 ------*------------------------------------------------------------------------------------------------------------------------
 172.  *   0.0   0.0   0.0   0.1   0.1   0.0   0.0   0.0   0.1   0.0   0.1   0.1   0.0   0.0   0.1   0.0   0.2   0.0   0.0   0.0
1
                                                                                                                    PAGE  4
     JOB: THOMAS AND GRAND INTERSECTION                       RUN: 2015 TMS Set A (1-60)         Hour:  24

      MODEL RESULTS
      -------------

      REMARKS : In search of the angle corresponding to
                the maximum concentration, only the first
                angle, of the angles with same maximum
                concentrations, is indicated as maximum.

 WIND  * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC21 REC22 REC23 REC24 REC25 REC26 REC27 REC28 REC29 REC30 REC31 REC32 REC33 REC34 REC35 REC36 REC37 REC38 REC39 REC40
 ------*------------------------------------------------------------------------------------------------------------------------
 172.  *   0.0   0.0   0.0   0.0   0.0   0.0   0.2   0.3   0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
1
                                                                                                                    PAGE  5
     JOB: THOMAS AND GRAND INTERSECTION                       RUN: 2015 TMS Set A (1-60)         Hour:  24

      MODEL RESULTS
      -------------

      REMARKS : In search of the angle corresponding to
                the maximum concentration, only the first
                angle, of the angles with same maximum
                concentrations, is indicated as maximum.

 WIND  * CONCENTRATION
 ANGLE *      (PPM)
 (DEGR)* REC41 REC42 REC43 REC44 REC45 REC46 REC47 REC48 REC49 REC50 REC51 REC52 REC53 REC54 REC55 REC56 REC57 REC58 REC59 REC60
 ------*------------------------------------------------------------------------------------------------------------------------
 172.  *   0.1   0.1   0.0   0.0   0.0   0.0   0.1   0.1   0.0   0.0   0.1   0.0   0.0   0.1   0.0   0.1   0.1   0.1   0.1   0.0
 THE HIGHEST CONCENTRATION IS    0.30 PPM AT  172 DEGREES FROM REC28.
```

APPENDIX VII

2006 and 2015 EMISSION INVENTORY DEVELOPMENT

App.VII-i

Onroad Vehicle Emission Factor Estimation Procedure for 2006 and 2015

App.VII-i is followed by an attachment containing a sample of the MOBILE6 input files for 2015.

ONROAD VEHICLE EMISSION FACTOR ESTIMATION PROCEDURE FOR 2006 and 2015

Emission Factor Model

Carbon monoxide (CO) vehicle exhaust emission factors were calculated using MOBILE6, a model developed by the Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors. The MOBILE6 runs were executed by the Maricopa Association of Governments (MAG). The contact person for the MOBILE6 emission estimates is Roger Roy (602-254-6300). More information about the MOBILE6 model may be found in the EPA User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, January 2002, EPA420-R-02-001., which may be found at the web site http://www.epa.gov/otaq/models/mobile6/r02001.pdf.

A series of MOBILE6 runs were performed to create a complete set of emission factors for input to the M6Link model.

Two Inspection/maintenance (I/M) scenarios were modeled:

1. With an I/M program in place.

2. No I/M program in place.

Five area types were modeled:

1. Central Business District

2. Urban Area

3. Urban Fringe

4. Suburban

5. Rural

Two days were modeled:

1. Friday

2. Saturday

Each combination of the above scenarios was processed through the MOBILE6 model for a total of 20 MOBILE6 runs (2 I/M status conditions X 5 area types X 2 days).

The results of the I/M and non-I/M runs for each of the five area types were combined to reflect the proportions of I/M and non I/M vehicles by the M6Link program. The term I/M vehicles means vehicles which are required to undergo an emission test and inspection under the Arizona Vehicle Inspection/Maintenance Program. It is important to note that the I/M program is required for all vehicles of the appropriate age *registered* in the nonattainment area. However, it is assumed that 91.6 percent of the vehicles *operating* within the nonattainment area will participate in the I/M program, and that 8.4 percent will not participate in the program. These percentages reflect implementation of the committed control measure "Tougher Enforcement of Vehicle Registration and Emission Test Compliance". In the absence of any additional data, this percentage split is assumed to apply directly to VMT as well. Refer to ATTACHMENT ONE for the actual input files for 2015 run.

Development of Model Inputs

The inputs to MOBILE6 are grouped into three categories: Header inputs, Run inputs, and Scenario inputs. The input values used in the above described MOBILE6 runs are specified and explained below.

Header Section

1. **MOBILE6 INPUT FILE** identifies a MOBILE6 input file as a regular command input file rather than a batch file.

2. **DATABASE OUTPUT** instructs MOBILE6 to report output in database format.

3. **WITH FIELDNAMES** specifies that a header record of field names is to be generated for the database output file.

4. **DATABASE EMISSIONS : 2222 2222** indicates that all emissions types are reported in database output format if appropriate. The eight emission types are exhaust running emissions, exhaust start emissions, evaporative hot soak emissions, evaporative diurnal emissions, evaporative resting loss emissions, evaporative running loss emissions, evaporative crankcase emissions, and evaporative refueling emissions. For carbon monoxide, only exhaust running emissions and exhaust start emissions are relevent.

5. **DATABASE FACILITIES : Arterial Freeway Local Ramp None** instructs MOBILE6 to output emissions in the database output table specific to each of the four roadway types modeled by MOBILE6. Also, emissions that are independent of roadway type are output separately by MOBILE6.

6. **DATABASE VEHICLES : 22222 22222222 2 222 22222222 222** instructs MOBILE6 to output emission factors for all 28 vehicle classes considered by MOBILE6.

7. **POLLUTANTS : CO** instructs MOBILE6 to output emission factors for MOBILE6 only.

Run Data Section

The run data section includes information about the local inspection and maintenance programs, the anti-tampering program, and local vehicle registration data.

1. **I/M PROGRAM :1 1977 2050 1 T/O LOADED/IDLE** instructs MOBILE6 to model an I/M program with an I/M program start year of 1977 and 2050 end year. The program is an annual program “1". The program is a Test only rather than test and repair program “T/O”. Finally, the program is a loaded/idle program. It is important to note that this command appears five times in the MAG I/M run reflecting five components of the I/M program.

2. **I/M MODEL YEARS : 1 1967 2050** instructs MOBILE6 that the portion of the I/M program defined in the “I/M PROGRAM” line is applied to model year 1967 through 2050 model year vehicles. It is important to note that this command appears five times in the MAG I/M run reflecting five components of the I/M program.

3. **I/M VEHICLES : 1 11111 22222222 2** this instructs MOBILE6 which vehicle classes are subject to this component of the I/M program where the number two indicates that a particular vehicle class is subject to the program and the number one indicates that a particular vehicle class is not subject to the program.

4. **I/M STRINGENCY : 1 28.0** defines that the expected exhaust inspection failure rate for pre-1981 model year vehicles covered by the I/M program is 28.0 percent.

5. **I/M COMPLIANCE : 1 97.0** describes the expected compliance rate within this portion of the I/M program where the compliance rate is the percentage of vehicles in the fleet that complete the I/M program and receive either a certificate of compliance or a waiver.

6. **I/M WAIVER RATES: 1 1.3 1.0** specifies the percentage of vehicles that fail an initial I/M test and do not pass a retest but receive a certificate of compliance. This input instructs MOBILE6 to set the waiver rate at 1.3 percent for pre-1981 model years and 1.0 percent for 1981 and later model years for this portion of the I/M program.

7. **I/M GRACE PERIOD : 1 5** specifies that the vehicles first become subject to the local I/M program at five years of age.

8. **ANTI-TAMP PROG : 87 75 80 22222 22222222 2 11 097. 22111222** indicates information for the local anti-tampering program. Note that there may be more than one component of an anti-tampering program, requiring multiple inputs of this data.

   “**87**" indicates that the program began in 1987.
   “**75**" indicates that the earliest model year covered by the program is 1975.
   “**80**" indicates that the last model year covered by the program is 1980.
   “**22222**" indicates that the five light duty gasoline vehicle classes considered by MOBILE6 are all subject to this portion of the anti-tampering program.

“**22222222**" indicates that the eight heavy duty gasoline vehicle classes considered by MOBILE6 are all subject to this portion of the anti-tampering program.
“**2**" indicates that the gasoline powered buses are subject to this portion of the anti-tampering program.
“**11**" indicates that credit is to be taken for the anti-tampering program and that the test is performed annually.
“097.” indicates that the program compliance rate is 97 percent.
“**22111222**" indicates that the ATP program consists of an air pump system disablement test, catalyst removal test, evaporative system disablement test, PCV system disablement test, and missing gas cap test. Omitted from the program are a fuel inlet restrictor disablement test, tailpipe lead deposit test, and EGR disablement test.

9. **REG DIST: tjreg.d** indicates that local registration distribution data is provided for MOBILE6 use, rather than national default data, and that these data may be found in the external data file tjreg.d. The data input to the runs performed for this analysis reflect ADOT registration data developed in 1999.

10. **DIESEL FRACTIONS :** indicates that the user is inputting data to reflect the fraction of vehicles by vehicle class that are diesel powered, where appropriate. In the case of MAG analysis, local data is used for the vehicle classes light duty gasoline vehicles, light duty trucks 1, and light duty trucks 2. For the remaining vehicle classes, MOBILE6 default data was input. Please note that the 42 lines of registration data following the DIESEL FRACTIONS: command have not been reproduced here, but may be seen in the sample MOBILE6 input file provided with this document.

<u>**Scenario Data Section**</u>

1. **SCENARIO RECORD : I/M Scenario** is a required field that provides a unique identifier to each scenario analyzed. The individual MOBILE6 runs performed by MAG for this analysis each have only one scenario.

2. **WE VEH US :** is an input used only for the Saturday runs performed by MAG. This flag instructs MOBILE6 to apply weekend activity information in calculating emissions that depend on vehicle usage rates, such as engine start emissions

3. **WE EN TRI LEN DI : weentrip.d** is an input only used for the Saturday runs performed by MAG. This flag allows users to specify the fraction of weekend VMT that occurs during trips of various durations at each hour of the day. The data is input to MOBILE6 through an external data file with the file name “weentrip.d”.

4. **CALENDAR YEAR : 2007, 2016** indicates that the year analyzed is 2007 or 2016.

5. **EVALUATION MONTH : 1** indicates that the month analyzed was January (where January and July are the only months available for analysis by MOBILE6). Since the periods subject to analysis was December 2015 and December 2006, the

closest months available to model were January of 2016 and January of 2007.

6. **ALTITUDE : 1** indicates that the runs are being performed for a low-altitude region. The low altitude flag represents approximately 500 feet above sea level and the high altitude flag represents approximately 5,500 feet above sea level.

7. **HOURLY TEMPERATURES:** indicates the 24 hourly temperatures for the day being modeled, starting at 6 a.m. and ending at 5 a.m. the next morning in degrees Fahrenheit.

8. **SPEED VMT: svmta3SA** indicates that the user has chosen to provide an external data file, svmta3SA, that contains hourly speed distributions for both freeway and arterial roadway types

9. **FUEL RVP : 9.0** indicates that the measure of fuel volatility Reid Vapor Pressure is expected to be 9.0 pounds per square inch during the period modeled.

10. **FUEL PROGRAM: 4** instructs MOBILE6 that the user will supply the gasoline sulfur levels, expressed as parts per million. The runs performed for this analysis include a sulfur content of 30 parts per million (ppm) for both the average and maximum sulfur levels. The sulfur values input are based upon the MathPro draft report Evaluation of Gasoline and Diesel Fuel Options for Maricopa County, January 30, 1998 of an average of 20 ppm for CARB Phase 2 RFG with 3.5 percent oxygenate by weight. MOBILE6 does not allow a sulfur content of less than 30 ppm

11. **OXYGENATED FUELS : 0.000 1.000 0.000 0.035 1** indicates that the gasoline sold during the time period modeled is expected to have zero market share of ether and a 100 percent market share of ethanol as an oxygenate additive. The average oxygen content of ether is zero percent and the average oxygen content of ethanol blend fuels is 3.5 percent by weight. The number 1 indicates that there is no RVP waiver granted for alcohol based oxygenates.

Model Outputs

MOBILE6 was executed with the inputs described above to obtain a database of emission factors in grams per mile (g/mi) for exhaust CO. The database of emission factors represented emission factors split out by the vehicle classes, vehicle ages, hour of the day, roadway (facility) type on which the vehicle is driving. These outputs, in the units of grams per mile were input to the M6Link system for further processing.

ATTACHMENT ONE

MOBILE6 INPUT FILES

Attachment One contains a portion of the MOBILE6 input files for the I/M and no I/M runs for the modeling year 2015. The sample inputs reflects Area Type number 1 (central business district) and the Saturday modeling day. The I/M input appears first followed by the no I/M input. The equivalent files for the modeling year 2006 would be identical to those shown below except have a modeling year of 2007 and contain different registration distribution and diesel fractions data.

```
MOBILE6 INPUT FILE :
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DATABASE EMISSIONS : 2222 2222
DATABASE FACILITIES: Arterial Freeway Local Ramp None
DATABASE VEHICLES  : 22222 22222222 2 222 22222222 222
POLLUTANTS         : CO

RUN DATA
I/M PROGRAM        : 1 1977 2050 1 T/O LOADED/IDLE
I/M MODEL YEARS    : 1 1967 2050
I/M VEHICLES       : 1 11111 22222222 2
I/M STRINGENCY     : 1 28.0
I/M COMPLIANCE     : 1 97.0
I/M WAIVER RATES   : 1 1.3 1.0
I/M GRACE PERIOD   : 1 5
I/M PROGRAM        : 2 1977 2050 2 T/O IM240
I/M MODEL YEARS    : 2 1981 1995
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 28.0
I/M COMPLIANCE     : 2 97.0
I/M WAIVER RATES   : 2 1.3 1.0
I/M GRACE PERIOD   : 2 5
I/M CUTPOINTS      : 2 CUTPNT15.d
I/M PROGRAM        : 3 1977 2050 1 T/O LOADED/IDLE
I/M MODEL YEARS    : 3 1967 1980
I/M VEHICLES       : 3 22222 11111111 1
I/M STRINGENCY     : 3 28.0
I/M COMPLIANCE     : 3 97.0
I/M WAIVER RATES   : 3 1.3 1.0
I/M PROGRAM        : 4 2001 2050 2 T/O OBD I/M
I/M MODEL YEARS    : 4 1996 2050
I/M VEHICLES       : 4 22222 11111111 1
I/M STRINGENCY     : 4 28.0
I/M COMPLIANCE     : 4 97.0
I/M WAIVER RATES   : 4 1.3 1.0
I/M GRACE PERIOD   : 4 5
I/M PROGRAM        : 5 2001 2050 2 T/O EVAP OBD & GC
I/M MODEL YEARS    : 5 1996 2050
I/M VEHICLES       : 5 22222 11111111 1
I/M STRINGENCY     : 5 28.0
I/M COMPLIANCE     : 5 97.0
I/M WAIVER RATES   : 5 1.3 1.0
I/M GRACE PERIOD   : 5 5

ANTI-TAMP PROG     :
87 75 80 22222 22222222 2 11 097. 22111222
ANTI-TAMP PROG     :
87 81 95 11111 22222222 2 11 097. 22111222

*the tech12.d file must be located with Mobile6 execution file
*the user tech file tech12.1me should be renamed as tech12.d
*Two more I/M programs should not have overlapped motor vehicles.

REG DIST           : tjreg.d
DIESEL FRACTIONS   :
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0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0020 0.0040 0.0030
0.0030 0.0030 0.0020 0.0020 0.0030
0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040 0.2040
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0.0470 0.0360 0.0240 0.0390 0.0310
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0.0126 0.0115 0.0111 0.0145 0.0115
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0.6774 0.7715 0.7910 0.8105 0.8068
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SCENARIO RECORD     : I/M Scenario
WE VEH US           :
WE EN TRI LEN DI    : weentrip.d
CALENDAR YEAR       : 2016
EVALUATION MONTH    : 1
ALTITUDE            : 1
HOURLY TEMPERATURES: 41.8 41.1 41.3 46.4 54.6 61.1 69.7 72.8 74.8 75.2 73.6 65.5
                     58.8 55.6 53.2 50.8 49.8 49.0 44.8 43.4 42.7 42.2 42.5 41.7
SPEED VMT           : svmta1SA.txt
FUEL RVP            : 9.0
FUEL PROGRAM        : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT      : 30.0
OXYGENATED FUELS    : 0.000 1.000 0.000 0.035 1

END OF RUN
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MOBILE6 INPUT FILE :
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DATABASE EMISSIONS : 2222 2222
DATABASE FACILITIES: Arterial Freeway Local Ramp None
DATABASE VEHICLES  : 22222 22222222 2 222 22222222 222
POLLUTANTS         : CO


RUN DATA


REG DIST           : tjreg.d
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0.9992 0.9989 0.9987 0.9989 0.9977
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0.9585 0.8857 0.8525 0.8795 0.9900

SCENARIO RECORD    : I/M Scenario
WE VEH US          :
WE EN TRI LEN DI   : weentrip.d
```

```
CALENDAR YEAR      : 2016
EVALUATION MONTH   : 1
ALTITUDE           : 1
HOURLY TEMPERATURES: 41.8 41.1 41.3 46.4 54.6 61.1 69.7 72.8 74.8 75.2 73.6 65.5
                     58.8 55.6 53.2 50.8 49.8 49.0 44.8 43.4 42.7 42.2 42.5 41.7
SPEED VMT          : svmta1SA.txt
FUEL RVP           : 9.0
FUEL PROGRAM       : 4
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
SULFUR CONTENT     : 30.0
OXYGENATED FUELS   : 0.000 1.000 0.000 0.035 1

END OF RUN
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App.VII-ii

Traffic Data

App.VII-ii contains a detailed description of the traffic data used to estimate onroad mobile source emissions.

Socioeconomic Projections The 1995, 2006, and 2015 population and employment for Maricopa County assumed in developing onroad mobile emissions for the CO maintenance plan are summarized in Table 1. The 1995 population and employment estimates are based on the 1995 Special Census for Maricopa County and the 1995 MAG Employment Survey, respectively. The 2006 and 2015 population and employment projections are the most recent forecasts that have been officially approved by the Metropolitan Planning Organization (i.e., MAG). These projections are based on the Maricopa County population control totals developed by the Arizona Department of Economic Security in accordance with Executive Order 95-2. State agencies are required to use these forecasts for all planning purposes except where otherwise noted in the State Statutes. The Maricopa County totals were disaggregated to traffic analysis zones (TAZs) by MAG, using land use models and data from the 1995 Special Census and 1995 MAG Employment Survey.

In June 1997, the MAG Regional Council approved the TAZ estimates and projections of population and employment used in this analysis. These allocations take into account growth associated with programmed and planned transportation improvements. Population and employment, along with other socioeconomic characteristics, are input to the MAG travel demand models to produce travel and level of service estimates.

Travel Demand Models In 1994 MAG converted its transportation models from the mainframe-based Urban Transportation Planning System (UTPS) to a UNIX workstation version of EMME/2. Since that time, the MAG EMME/2 travel demand models, with a series of enhancements, have been validated against more than 4,000 1998 traffic counts. The enhanced EMME/2 models, now executing on microcomputers with an NT operating system, were used to develop the regional traffic forecasts for the CO maintenance plan.

The vehicle miles of travel (VMT) estimated by the MAG EMME/2 transportation models track closely with the Highway Performance Monitoring System (HPMS). HPMS is prepared each year by the Arizona Department of Transportation (ADOT) and submitted to the Federal Highway Administration. MAG submitted VMT tracking reports to EPA in 1999, 2000 and 2001 to fulfill a Serious Area CO Plan requirement. These reports showed that the VMT produced by the MAG transportation models is within three percent of actual HPMS VMT reported by ADOT. This confirms that the MAG travel demand model estimates are consistent with actual VMT reported by HPMS each year.

As part of enhancements to the EMME/2 models, the MAG trip distribution model was re-calibrated to operationalize a speed feedback loop. This feedback loop, which stabilizes in five iterations, simulates the impact which traffic congestion has on the length and destination of person trips. A composite impedance function (i.e., time and cost) is also used in the trip distribution and traffic assignment models. In addition, improved freeway and arterial speeds, derived from the 1993 MAG Travel Speed and Delay Study, Maricopa Association of Governments, March 1995, are being used to ensure that the capacity-restrained speeds and delays in the model are consistent with empirical data.

Traffic Assignments One output of the MAG EMME/2 travel demand models is a traffic assignment. Traffic assignments are useful in preparing a spatially-accurate representation of CO emissions from onroad mobile sources. To support the CO maintenance plan, 1995, 2006, and 2015 traffic assignments were prepared using the latest socioeconomic projections, EMME/2 travel demand models, and highway and transit networks.

Table 1 summarizes traffic characteristics output by MAG traffic assignments for 1995, 2006, and 2015. The population and employment data shown in this table represent Maricopa County. All other data pertain to the transportation modeling area for the MAG 1541 traffic analysis zone system.

"Freeway Lane Miles" include metered and non-metered freeway ramps. "Percent PM Peak Freeway Lane Miles Congested" is the share of lane miles on freeways and ramps with a volume to practical capacity ratio above 0.90 during the PM peak hour. Table 2 summarizes VMT by facility type for 1995, 2006, and 2015. The "Average Weekday VMT" in Tables 1 and 2 was derived from 24-hour traffic assignments for 1995, 2006, and 2015.

For the CO maintenance plan, the 1995, 2006, and 2015 assignments were performed for four vehicle classes (light-duty commercial truck, medium-duty commercial truck, heavy-duty commercial truck, and all other vehicles) and four times of day (AM peak, midday, PM peak, and nighttime). Each of these sixteen assignments estimates the number of vehicles and capacity-restrained speeds on each highway link. There are more than 30,000 one-way links in a typical MAG highway network. The sixteen link files output by these assignments were input to the M6Link onroad mobile source emissions program described in Appendix III-ii. The 1995 traffic volumes were adjusted to represent 1994 base case conditions by M6Link.

TABLE 1

TRAFFIC ASSIGNMENT CHARACTERISTICS

Year	Resident Population[a] (1,000's)	Total Employment[a] (1,000's)	Average Weekday VMT (1,000's)	Freeway Lane Miles[b]	Percent PM Peak Freeway Lane Miles Congested[c]
1995	2,529	1,265	59,673	1,206	18.6%
2006	3,406	1,718	90,017	1,979	25.6%
2015	4,102	2,043	120,406	2,319	37.4%

[a] Resident population and total employment estimates/projections for Maricopa County.
[b] Metered and non-metered ramps are included in the freeway lane miles.
[c] Percent of freeway (including ramps) lane miles on which the traffic volume exceeds 90 percent of lane capacity during the PM peak hour.

TABLE 2

VMT BY FACILITY TYPE

(in thousands of VMT per average weekday for the transportation modeling area)

Year	Freeways[d]	Arterials	Collectors	Locals	Total
1995	15,581	35,477	2,194	6,421	59,673
2006	30,090	47,679	2,919	9,329	90,017
2015	39,843	64,639	3,854	12,070	120,406

[d] Includes VMT on metered and non-metered freeway ramps.

Growth Factors

App.VII-iii contains growth factors based on the 2006 and 2015 population projections approved by the MAG Regional Council in June 1997 and developed from the 1995 Special Census. The 2006 and 2015 employment factors by SIC were based on from projections prepared by the Arizona Department of Economic Security.

For evaluating maintenance of carbon monoxide (CO) National Ambient Air Quality Standards (NAAQS), an estimate of emissions in 2006 and the 2015 maintenance year is necessary. MAG has created the growth factors to project emissions from the 1999 Periodic Carbon Monoxide Emissions Inventory, MCESD, November 2001 to the CO modeling years 2006 and 2015. Consistent with the methodology used in the Serious Area Plan, these factors are based on population forecasts approved by the MAG Regional Council in June 1997 and developed from the 1995 Special Census and employment forecasts by Standard Industrial Classification (SIC) provided by the Arizona Department of Economic Security. The growth factors were developed to estimate future emissions based on changes in population, employment, land use, agriculture, and aviation.

BACKGROUND

State and local air pollution control agencies responsible for ozone and CO nonattainment areas are required to prepare base year and future year (including maintenance year) inventories. These inventories are a critical component of State Implementation Plans (SIPs) and are required as a result of the U.S. Environmental Protection Agency's (EPA) programs for the control of ground level ozone and CO. The development of the growth factors used to project the 1999 annual CO emissions to 2006 and 2015 are described below. A Notable exception are power plants, where maximum permit data is used for 2006 and 2015 emissions.

The 1999 Periodic Carbon Monoxide Emissions Inventory, MCESD, November 2001, and the EPA guidance document Procedures For Preparing Emissions Projections, EPA450/4-91-019, May, 1991 were used to develop growth factors. The following equation, obtained from the Procedures document, illustrates the calculation of growth factors:

$$\begin{array}{c}\textit{Projected Year}\\ \textit{Growth Factor}\end{array} = \frac{\begin{array}{c}\textit{Value of Growth}\\ \textit{Indicator in Projection Year}\end{array}}{\begin{array}{c}\textit{Value of Growth}\\ \textit{Indicator in Periodic Year}\end{array}}$$

Growth factors were applied to the 1999 annual CO emissions for point (except power plant emissions), area and nonroad mobile sources to determine annual projected emissions. As indicated above, 2006 and 2015 power plant emissions were considered to be at the maximum level defined in the permits.

Growth Factors

Details on how the growth factors were estimated are discussed on the following pages. The categories for these growth factors include: Socioeconomic, Land Use, Agricultural, Aviation, and Little Use. For each category, growth factors are based on one or more growth indicators. Although several growth factors were obtained from annual projections (i.e. employment Standard Industrial Classifications (SICs)), other growth projections were extrapolated from data not available on an annual basis. For example, population estimates were only available in five-year increments.

Socioeconomic Growth Factors

In June 1997, MAG approved population forecasts based on the 1995 Special Census. Estimated employment in Maricopa County by SIC is available from AzDES for the years 1973 through 2010. These data were extrapolated to 2015 by MAG as described in ATTACHMENT ONE. ATTACHMENT TWO provides an explanation of the SIC codes. The population projections for Maricopa County were also developed by AzDES for the years 2000 through 2020, by five year increments. The population projections used to develop the 2006 and 2015 growth factors are summarized in Table 1. The general methodology for creating a growth factor consisted of dividing the value of the growth indicator in the projection year by the value of the growth indicator in the base year. For example, the growth factor from 1999 to 2015 for a category based on population is 4,101,775 divided by 2,913,475 or 1.41.

TABLE 1. MARICOPA COUNTY RESIDENT POPULATION

YEAR	POPULATION
1999	2,913,475
2006	3,402,305
2015	4,101,775

Table 2 displays the growth factors for point sources other than peaking power plants. It is important to note that emissions from the existing peaking power plants and the new base load units for 2006 and 2015 were estimated by MCESD based on the maximum operation levels defined in the permits or applications. The data listed in the "Reference" column in Table 2 identify the growth indicator used to create the growth factor for each point source.

TABLE 2. 2006 and 2015 POINT SOURCE GROWTH FACTORS

Facility ID	Business Name	SIC	2006 GF	2015 GF	Reference
1075	91st Ave. Wastewater Treatment Plant	4952	1.25	1.59	48
1074	City of Phoenix 23rd Ave. Wastewater Treatment Plant	4952	1.25	1.59	48
29919	City of Phoenix 27th Ave. Landfill	4953	1.17	1.41	Pop
40233	City of Scottsdale/Water Services Division	9511	1.17	1.41	Pop
26	Empire Machinery Co.	5082	1.44	2.02	MAWTRD
807	Grove Cogeneration Plant	4911	1.25	1.59	48
1437	Hadco Phoenix Inc./Sanmina Phoenix Division	3672	1.09	1.24	3334
3536	Holsum Bakery Inc.	2051	1.09	1.17	20
355	Honeywell International Inc.	3724	0.99	0.93	19
354	Imsamet of Arizona	3341	1.09	1.24	3334
31617	Intel Corp. Chandler Campus (Fab 6)	3674	1.19	1.40	36
3966	Intel Corp. Chandler Campus (Fab 12)	3674	1.19	1.40	36
3300	Luke Air Force Base	9711	1.00	1.00	No Growth
744	ME West /Capitol Castings Inc.	3325	1.09	1.24	3334
1254	Maricopa Medical Center	8062	1.17	1.41	Pop
1414	Mesa Materials Inc. (Mesa)	1442	1.26	1.69	17
1415	Mesa Materials Inc. (Phoenix)	1442	1.26	1.69	17
881	Motorola Inc.	3674	1.19	1.40	36
1151	Motorola Logic & Analog Tech Group	3674	1.19	1.40	36
223	MTD Southwest Inc.	3524	1.16	1.37	38

1878	North Phoenix Baptist Church	8661	1.34	1.83	84
212	ON Semiconductor	3674	1.19	1.40	36
98	Palo Verde Nuclear Generating Station	4911	1.17	1.41	Pop
1014	Phoenix Brick Yard	3251	1.16	1.37	38
238	Pre-Cast Manufacturing Co.	3272	1.16	1.37	38
1030	Quebecor World-Phoenix Division	2752	1.15	1.33	27
808	Scottsdale Princess Cogeneration Plant	4911	1.25	1.59	48
4175	SFPP LP	4226	1.35	1.84	75
101	Sunland Beef Co.	2011	1.09	1.17	20
249	The Boeing Company	3721	0.99	0.93	19
232	The Phoenician Resort	7011	1.09	1.12	70
234	United Dairymen of Arizona	2023	1.09	1.17	20
201	United Metro Materials Inc. Plant #1	1442	1.26	1.69	17
260	United Metro Materials Inc. Plant #11	1442	1.26	1.69	17
213	United Metro Materials Inc. Plant #12	1442	1.26	1.69	17
403	VAW of America Inc.	3354	1.16	1.37	38
20706	Wincup Holdings Inc.	3086	1.16	1.37	38

Table 3 displays the growth factors for area sources, aircraft, and locomotives. The data listed in the "Reference" column identify the growth indicator used to create the growth factor for each source. The fireplace and woodstove activity levels for 1999 were estimated from 1996 based on a local survey of activity levels which included woodburning fireplaces, woodstoves, and woodburning barbeques/firepits and the number of residential housing units in the Maricopa County Nonattainment area from 1994 demographics data. These activity levels were combined with emission factors for estimating emissions from residential wood combustion obtained from AP-42. It is important to note that the survey reflects the implementation of the Maricopa County Residential Wood Combustion Ordinance. The 2006 and 2015 growth factors listed in Table 3 for fireplaces and woodstoves represents a projection of the 1999 emissions to 2006 and 2015, based on the change in population from 1999 to 2006 and 2015 respectively.

The growth factors for nonroad equipment are contained in ATTACHMENT THREE. The data listed in the "Reference" column identify the growth indicator used to create the growth factor for each nonroad equipment type. The nonroad equipment types are split into three subcategories: two-stroke gasoline engines, four-stroke gasoline engines, and diesel engines. It is important to note that the growth factors listed in this memo do not reflect the effect of implementation of the Federal Phase 2 nonroad engine standards.

Land Use Growth Factors

Growth factors for some nonroad equipment categories and off-road vehicles were based on 1990 and 1995 Geographic Information System (GIS) coverages of land use in Maricopa County (refer to ATTACHMENT FOUR). As shown in ATTACHMENT THREE, emissions from lawn mowers, rear engine riding mowers, front mowers, lawn & garden tractors, and other lawn & garden equipment types were projected based on changes in developed land. The growth factors for developed land were based on the changes in developed land acres between 1990 and 1995 for the CO nonattainment area (refer to ATTACHMENT FOUR). The increase in acres for the five-year period was annualized and extrapolated through 2015. The annual growth was used to estimate lawn/garden growth factors presented in ATTACHMENT FOUR. A similar procedure was used to calculate growth factors for off-road vehicles. As shown in ATTACHMENT THREE, emissions from all-terrain vehicles, minibikes, and off-road motorcycles were projected based on undeveloped land which was derived from 1990 and 1995 GIS coverages of vacant land in Maricopa County. The results of this procedure are presented in ATTACHMENT FOUR.

In addition, the City of Phoenix conducted a survey to determine changes in residential landscaping from 1990 to 1993. The results of the survey indicated that 2.4 percent of the households converted from grass to desert landscaping during this period. Therefore, projection of the 1990 lawn/garden levels from the NEVES study needed to reflect this shift in landscape preferences. This shift in preferences was accounted for in a manner consistent with the methodology developed by MCESD. For example, the 1991 adjusted lawn/garden growth factor = 1.02599 x (1-0.024) = 1.00137. (Refer to the adjusted lawn/garden factors in ATTACHMENT FOUR).

The developed and undeveloped land growth factors used to project emissions from 1999 to 2006 and 2015 were obtained by dividing the 2006/1999 and 2015/1999 growth factors by the 1999/1990 growth factor. These growth factors reflect the adjustments described above.

TABLE 3. 2006 and 2015 AREA SOURCE, AIRCRAFT, AND LOCOMOTIVE CO GROWTH FACTORS

Area Source Fuel Combustion Category	ASC	2006 Growth Factor	2015 Growth Factor	Reference
Indust; Natural Gas; External Comb	2102006001	1.22	1.50	DES#MAMAN+MAMIN+MATRD
Indust; Fuel oil; External Comb	2102004000	1.22	1.50	DES#MAMAN+MAMIN+MATRD
Com/Inst; Nat Gas; External Combustion	2103006000	1.22	1.50	DES#MAMAN+MAMIN+MATRD
Com/Inst; Internal Comb; Nat Gas Turbine Engines	2103006002	1.17	1.41	Pop
Residential; Natural Gas; External Combustion	2104006000	1.17	1.41	Pop
On-Site Incineration	2601000000	1.17	1.41	Pop
Open Burning	2610000000	1.00	1.00	No growth
Fireplaces	2104008000	1.17	1.41	Pop
Forest Wildfires	2810001000	1.00	1.00	No growth
Structure Fires	2810030000	1.17	1.41	Pop
Motor Vehicle Fires	2810050000	1.17	1.41	Pop
Railroad Equipment	2285000000	1.17	1.41	Pop
Aircraft - Air Carrier	2275020000	1.24	1.46	Carrier ops
Aircraft - General	2275050000	1.00	0.81	General ops
Aircraft - Auxiliary Power Units	2275070000	1.00	0.81	General ops
Aircraft - Military	2275001000	1.00	1.00	Military ops - no growth

TABLE 4. MARICOPA COUNTY LAND USE GROWTH FACTORS

	Developed Land	Undeveloped Land
1990 Land Use Acreage	357,937	524,125
1995 Land Use Acreage	404,452	476,545
1999/1990 Growth Factor	1.20	0.84
2006/1999 Growth Factor	1.15	0.85
2015/1999 Growth Factor	1.34	0.65

Agricultural Growth Factors

Nonroad mobile equipment related to agricultural activities was projected using the change in total harvested acreage as a growth indicator. The 1999, 2006 and 2015 acreage totals for Maricopa County are listed in Table 5. The 2006 and 2015 total acreage were estimated by assuming that the historical average annual change in acreage (from 1979 to 1999) was equal to the annual change from 1999 to 2015, a change of 8,615 acres per year. The 1995 Farm Bill discontinued the incentive for the agricultural set aside program. Under this program, farmers were paid to set aside a portion of their land and not farm on the set aside land. Emissions from agricultural land and activities for the 2006 and 2015 inventories were adjusted to reflect the impact of the discontinuation of the set aside program. The acreage harvested for 1999 was obtained from 1999 Arizona Agricultural Statistics, Arizona Agricultural Statistics Service, July 2000 and the historical annual change in acreage was obtained from Agricultural Statistics: Historical Summary of County Data 1978 to 1989, Arizona Agricultural Statistics Service, 1990, and the annual Arizona Agricultural Statistics for 1990 through 1999, Arizona Agricultural Statistics Service. Growth factors were derived by dividing the 2006 and 2015 total harvested acreage by the 1999 harvested acreage.

TABLE 5. CALCULATION OF ANNUAL GROWTH FOR FARM EQUIPMENT

Year	Acreage Harvested	Growth Factor
1999	236,000	
2006	175,695	0.74
2015	98,160	0.42

Aviation Growth Factors

Air Carrier operations are available as actual 1999 and forecasted 2015 Sky Harbor operations in the Regional Aviation System Plan (RASP) Update: Working Paper No. 2, Maricopa Association of Governments, September 2001. As with the other growth factors, the 2015/1999 growth factor was developed by dividing the 2015 forecasted operations by the 1999 actual operations. The 2015/1999 air carrier operations growth factor was used to project air carrier based aviation and related nonroad mobile source emissions from 1999 to 2015 and the same was done for general aviation operations. The 2006 growth factor was developed by doing a series trend growth from the forecasted 2005 Sky Harbor commercial and general aviation operations in the RASP to 2015.

Military operations were assumed to remain constant over time. Table 6 provides the information used to develop the 2006/1999 and 2015/1999 growth factors, including the 1999 operations, series trend growth 2006 operations and 2015 forecasted operations.

TABLE 6. AVIATION GROWTH FACTORS

Growth Factor Type	Actual 1999 Operations	Series Trend Growth 2006 Operations	Forecasted 2015 Operations	2006 Growth Factor	2015 Growth Factor
Air Carrier	476,327	592,671	695,800	1.24	1.46
General Aviation	69,027	68,785	55,720	1.00	0.81
Military	N/A	N/A	N/A	1.00	1.00

Little Use Growth Factors

Consistent with the assumptions MCESD incorporated into the 1999 Periodic Carbon Monoxide Inventory for Maricopa County, Arizona Nonattainment Area (MCESD, 2001), emissions for several nonroad equipment types were expected to change little over time due to the existing pattern of usage for these equipment categories. These sources included shredders <5HP, tillers <5HP, wood splitters, and chippers/stump grinders. Shredders and tillers are typically used at ranch-style residences on large lots with overgrown trees. Since ranch-style residences are rarely being built, the use of shredders and tillers was not expected to increase. Chippers/stump grinders are typically used to clear land for development. Due to the desert nature of the nonattainment area, these tools are rarely used for land clearing. As a result, a growth factor of 1.00 was applied to the aforementioned equipment categories.

ATTACHMENT ONE

2006 & 2015 Growth Factor Projections

Year	MIN	CON	CON15	CON16	CON17	MAMAN	MADUR	MAN19	MAN32	MA3334	MAN35	MAN36	MAN38
Average ∆ *	66	3393	-35	45	3654	3319	2780	-103	43	264	43	1578	781
1993	4500	60800	9297	7304	39598	134800	99800	18782	3600	12100	10214	34593	23462
1994	4400	73300	9823	7999	40610	142400	106100	19297	4000	13600	11145	35403	24358
1995	5724	84751	15095	8921	60736	148410	111247	16135	4547	14026	9319	39447	27773
1996	6706	90632	15673	10109	64850	153737	115856	16952	5059	14153	9501	42360	27832
1997	6706	92846	15611	9732	67503	158181	119773	17352	5197	14255	9642	44715	28612
1998	6504	91566	14012	8553	69001	161695	122868	17506	4902	14337	9795	47258	29070
1999	6370	91836	12881	7923	71032	165612	126109	17678	4784	14466	9981	49432	29768
2000	6240	92840	11864	7671	73305	169078	128943	17817	4717	14625	10151	51162	30471
2001	6119	94305	10993	7588	75724	172261	131537	17888	4642	14815	10303	52748	31141
2002	6019	96300	10266	7584	78450	175154	133897	17808	4577	14993	10437	54225	31857
2003	5927	98388	9659	7612	81117	177872	136074	17721	4522	15188	10562	55526	32555
2004	5846	100653	9211	7648	83794	180343	138061	17613	4467	15401	10668	56692	33219
2005	5754	103228	8909	7676	86643	182636	139916	17514	4418	15601	10796	57712	33875
2006	5669	105866	8732	7718	89416	184906	141839	17422	4383	15804	10893	58852	34485
2007	5644	108955	8638	7772	92545	186612	143256	17318	4357	15994	10958	59558	35071
2008	5633	112050	8602	7849	95599	188269	144631	17214	4335	16186	10991	60273	35632
2009	5630	115232	8627	7946	98659	189804	145901	17128	4326	16396	10980	60876	36195
2010	5624	118474	8694	8063	101717	191219	147058	17025	4330	16593	10947	61424	36738
2011	5690	121867	8659	8108	105371	194538	149838	16922	4373	16857	10990	63002	37519
2012	5756	125259	8623	8152	109025	197857	152618	16818	4416	17122	11033	64581	38300
2013	5822	128652	8588	8197	112679	201175	155398	16715	4459	17386	11076	66159	39081
2014	5888	132044	8552	8242	116333	204494	158178	16612	4502	17650	11119	67737	39862
2015	5955	135437	8517	8286	119987	207813	160957	16508	4545	17914	11163	69315	40643

*Average annual change in employment from 1993 to 2010

Year	MANDUR	MAN20	MAN26	MAN27	TCPU	TC4041	TC48	TRD	WTRD	RTRD	TRD53	TRD54	TRD55	TRD58
Average Δ*	545	158	106	271	3693	2469	1224	15648	6200	9448	1210	868	1227	3555
1993	34900	8000	15049	12000	55500	35800	19700	261800	60000	201800	31700	31700	23400	75300
1994	36300	8300	15151	12200	57900	37800	20100	285200	66700	218500	34000	33100	25700	80700
1995	37163	8787	15678	12698	64801	40467	24334	305596	73417	232180	35431	33151	27805	86190
1996	37881	9218	15686	12978	68932	42979	25953	323758	80750	243008	35265	35778	29922	90464
1997	38408	9452	15798	13158	72747	45414	27333	341515	86513	255002	36811	36922	31080	95061
1998	38827	9644	15942	13241	75789	47424	28365	357322	91418	265904	38688	37988	32211	99083
1999	39503	9827	16117	13559	79039	49653	29386	372992	96994	275998	40506	39014	33403	102650
2000	40135	10004	16262	13869	82311	51838	30473	388059	102717	285342	42131	39911	34505	105832
2001	40724	10174	16376	14174	85710	54170	31540	402856	108469	294387	43563	40789	35609	109007
2002	41257	10327	16458	14472	89112	56500	32612	417578	114435	303143	44883	41605	36713	112168
2003	41798	10451	16557	14790	92585	58929	33656	431818	120500	311318	46050	42395	37778	115085
2004	42282	10556	16640	15086	96103	61404	34699	445783	126646	319138	47109	43158	38798	117962
2005	42720	10640	16707	15373	99758	63983	35775	459726	132851	326875	48146	43849	39768	120911
2006	43067	10693	16740	15634	103419	66606	36812	473812	139228	334583	49060	44507	40682	124055
2007	43356	10714	16773	15869	107040	69271	37770	487444	145633	341811	49894	45085	41537	127032
2008	43638	10725	16790	16123	110718	72042	38676	500987	152041	348946	50693	45581	42451	130081
2009	43903	10714	16824	16365	114417	74851	39566	514388	158578	355809	51504	46037	43342	132942
2010	44161	10693	16858	16610	118286	77770	40515	527817	165397	362420	52276	46451	44252	135734
2011	44706	10851	16964	16881	121979	80239	41739	543465	171597	371868	53486	47319	45479	139289
2012	45251	11010	17071	17152	125673	82708	42964	559113	177797	381316	54697	48186	46705	142844
2013	45795	11168	17177	17424	129366	85176	44188	574761	183996	390765	55907	49054	47932	146399
2014	46340	11327	17284	17695	133059	87645	45413	590409	190196	400213	57117	49922	49158	149954
2015	46885	11485	17390	17966	136752	90114	46637	606057	196396	409661	58328	50790	50385	153509

*Average annual change in employment from 1993 to 2010

Year	TRD52	FIRE	FIRE60	FIRE64	SERV	SERV70	SERV73	SERV80	SERVOS	SERV71	SERV72	SERV75	SERV78	SERV81
Average Δ*	2582	2945	2049	978	28105	185	13052	4556	10472	884	494	1331	1634	-22
1993	39816	81300	37015	42913	312300	25400	76800	77800	129576	7261	13127	17055	15493	9835
1994	40973	86000	38079	45216	331700	23900	86200	81200	135618	7740	13047	17752	16335	10083
1995	48052	87359	42755	44603	371103	23875	101886	84828	160514	10040	14005	20912	22194	9539
1996	51579	94800	48504	46296	407277	24132	123402	88248	171496	11144	14510	21809	23315	9501
1997	55128	99822	52484	47338	442066	25127	141089	92091	183759	12172	14994	22965	25243	9516
1998	57934	102663	54698	47965	462960	25724	150151	96038	191047	12810	15364	23987	26434	9527
1999	60425	105749	56777	48972	486456	26238	160511	99976	199730	13502	15994	25162	27650	9537
2000	62963	108659	58707	49952	510582	26711	171105	104175	208592	14217	16618	26320	28922	9537
2001	65419	111193	60292	50901	535369	27138	182056	108550	217625	14942	17183	27478	30223	9537
2002	67774	113718	61799	51919	560875	27545	193525	113000	226804	15675	17733	28659	31553	9527
2003	70010	116126	63221	52905	587004	27903	205330	117633	236136	16411	18247	29892	32942	9527
2004	72110	118406	64548	53858	613640	28182	217445	122339	245674	17183	18721	31177	34358	9517
2005	74202	120612	65839	54773	640814	28408	229839	127232	255335	17956	19171	32487	35801	9508
2006	76279	122795	67090	55704	669038	28550	242710	132449	265329	18764	19650	33851	37233	9498
2007	78263	125005	68298	56707	697854	28607	255817	137879	275551	19608	20102	35239	38722	9489
2008	80141	127130	69459	57671	727460	28607	269375	143532	285946	20471	20564	36684	40194	9479
2009	81984	129233	70640	58594	758099	28578	283652	149274	296595	21372	21037	38151	41721	9470
2010	83706	131372	71841	59531	790083	28550	298685	155245	307604	22291	21521	39677	43265	9461
2011	86288	134317	73890	60509	818188	28735	311737	159801	318076	23175	22015	41008	44899	9439
2012	88870	137263	75938	61486	846293	28921	324789	164356	328548	24059	22509	42338	46532	9417
2013	91451	140208	77987	62464	874398	29106	337841	168912	339021	24943	23002	43669	48166	9395
2014	94033	143154	80035	63441	902503	29291	350893	173467	349493	25827	23496	45000	49800	9373
2015	96615	146099	82084	64419	930607	29476	363945	178023	359965	26712	23990	46331	51433	9351

*Average annual change in employment from 1993 to 2010

Year	SERV82	SERV83	SERV84	GOV	GOVSL	GOVSCH	GOVFED	MAN+MI	MAN+CO	#3334+#3
Average Δ *	340	3191	2615	4382	1493	3497	42	19033	6711	2667
1993	9195	25251	32460	159800	62520	67177	19075	401100	195600	80369
1994	9301	27970	33388	161000	65635	68972	19549	432000	215700	84506
1995	9263	34968	39594	157157	65136	73739	18283	459730	233161	90565
1996	10239	38470	42509	163665	66428	78422	18816	484201	244369	93846
1997	10995	42462	45412	169857	68101	82766	18990	506402	251027	97224
1998	11295	44654	46976	175612	69443	86948	19221	525521	253261	100460
1999	11634	47110	49142	181401	71040	90948	19413	544974	257448	103647
2000	11971	49654	51353	186757	72674	94495	19588	563377	261918	106409
2001	12294	52286	53682	191630	74273	97613	19745	581236	266566	109007
2002	12602	55004	56051	196237	75833	100541	19863	598751	271454	111512
2003	12904	57755	58459	200950	77349	103658	19943	615617	276260	113831
2004	13201	60642	60874	205666	78896	106768	20002	631972	280996	115980
2005	13491	63614	63308	210282	80395	109864	20022	648116	285864	117984
2006	13788	66667	65877	214895	81842	113050	20002	664387	290772	120034
2007	14078	69801	68512	219514	83316	116216	19982	679700	295567	121581
2008	14359	72942	71253	224323	84815	119586	19922	694889	300319	123082
2009	14661	76151	74032	229258	86342	123054	19863	709822	305036	124447
2010	14969	79502	76919	234302	87896	126622	19783	724660	309693	125702
2011	15309	82693	79534	238684	89389	130119	19825	743693	316404	128369
2012	15648	85884	82149	243067	90881	133616	19866	762726	323116	131035
2013	15988	89076	84765	247449	92374	137112	19908	781759	329827	133702
2014	16328	92267	87380	251832	93867	140609	19950	800792	336538	136369
2015	16667	95458	89995	256214	95360	144106	19991	819825	343250	139035

*Average annual change in employment from 1993 to 2010

ATTACHMENT TWO

Growth Factor Projection Column Heading Definitions

COLUMN HEADING DEFINITIONS	
Column Heading	**Corresponding Employment Category**
MAMIN or MIN	Total Mining Employment
MACON or CON	Total Construction Employment
CON15 or 15	General Building Construction Employment
CON16 or 16	Heavy (Street, Highway) Construction Employment
CON17 or 17	Special Trades Construction Employment
MAMAN or MAN	Total Manufacturing Employment
MADUR or DUR	Total Durable Goods Manufacturing Employment
MAN19 or 19	Aircraft Manufacturing Employment
MAN32 or 32	Aggregates Manufacturing Employment
MA3334 or 3334	Primary and Fabricated Materials Manufacturing Employment
MAN35 or 35	Nonelectric Machinery Manufacturing Employment
MAN36 or 36	Electric Equipment Manufacturing Employment
MAN38 or 38	Other Durables Manufacturing Employment
Employment Reference	Employment Category
MANDUR or NDUR	Total Nondurable Goods Manufacturing Employment
MAN20 or 20	Food and Kindred Manufacturing Employment
MAN26 or 26	Other Nondurable Goods Manufacturing Employment
MAN27 or 27	Printing Manufacturing Employment
TCPU	Transportation, Communications, and Public Utilities Employment
TC4041 or 4041	Transportation Employment
TC48 or 48	Communications and Public Utilities Employment
MATRD or TRD	Total Trade Employment
MAWTRD or WTRD	Total Wholesale Trade Employment
MARTRD or RTRD	Total Retail Trade Employment
TRD53 or 53	General Merchandise and Apparel Trade Employment
TRD54 or 54	Food Stores Trade Employment
TRD55 or 55	Auto Dealers and Services Trade Employment
TRD58 or 58	Eating and Drinking Services Trade Employment
TRD52 or 52	Other Trade Employment
FIRE	Total Finance, Insurance, and Real Estate Employment
FIRE60 or 60	Finance Employment
FIRE64 or 64	Insurance Employment

COLUMN HEADING DEFINITIONS	
Column Heading	**Corresponding Employment Category**
MASER or SERV	Total Services Employment
SERV70 or 70	Lodging Services Employment
SERV73 or 73	Business Services Employment
SERV80 or 80	Health Services Employment
SERVOS	Membership Organizations Services Employment
SERV71 or 71	Agricultural Services Employment
SERV72 or 72	Personal Services Employment
SERV75 or 75	Auto and Misc. Services Employment
Employment Reference	Employment Category
SERV78 or 78	Recreation and Amusement Services Employment
SERV81 or 81	Legal Services Employment
SERV82 or 82	Educational Services Employment
SERV83 or 83	Professional Services Employment
SERV84 or 84	Other Services Employment
GOV	Total Government Employment
GOVSL	State and Local Government Employment
GOVSCH	Public School Employment
GOVFED	Federal Government Employment
MAMAN+MACON	Total Manufacturing and Construction Employment
MAMAN+MAMIN+MATRD	Total Manufacturing, Mining, and Trade Employment

ATTACHMENT THREE

Growth Factors for Nonroad Equipment

2006 and 2015 NONROAD EQUIPMENT CO GROWTH FACTORS				
Nonroad Equipment Type	ASC Code	2006 GF	2015 GF	Growth Reference
2-Stroke Gasoline				
Trimmers/Edgers/Brush Cutters	2260004025	1.39	1.98	Employment - 71
Lawn Mowers	2260004010	1.15	1.34	Dev Land MAG /less grass lawns
Leaf Blowers/Vacuums	2260004030	1.39	1.98	Employment - 71
Chainsaws <4 HP	2260004020	1.00	1.00	LITTLE USE
Shredders <5 HP	2260004050	1.00	1.00	LITTLE USE
Tillers <5 HP	2260004015	1.00	1.00	LITTLE USE
Other Lawn & Garden Equipment	2260004075	1.15	1.34	Dev Land MAG /less grass lawns
Terminal Tractors	2260008010	1.24	1.46	Carrier ops
All Terrain Vehicles (ATVs)	2260001030	0.85	0.65	Undev Land MAG
Off-Road Motorcycles	2260001010	0.85	0.65	Undev Land MAG
Golf Carts	2260001050	1.38	1.91	Employment - MASER
Specialty Vehicles Carts	2260001060	1.38	1.91	Employment - MASER
Generator Sets <50 HP	2260006005	1.13	1.33	Employment - MAN+CON
Pumps <50 HP	2260006010	1.13	1.33	Employment - MAN+CON
Gas Compressors <50 HP	2260006020	1.13	1.33	Employment - MAN+CON
Aerial Lifts	2260003010	1.22	1.50	Employment - MAN+MIN+TRD
Forklifts	2260003020	1.22	1.50	Employment - MAN+MIN+TRD
Sweepers/Scrubbers	2260003030	1.22	1.50	Employment - MAN+MIN+TRD
Other General Industrial Equipment	2260003040	1.22	1.50	Employment - MAN+MIN+TRD
Tampers/Rammers	2260002006	1.15	1.47	Employment - CON
Plate Compactors	2260002009	1.15	1.47	Employment - CON
Paving Equipment	2260002021	1.15	1.47	Employment - CON
Bore/Drill Rigs	2260002033	1.15	1.47	Employment - CON
Chainsaws >4 HP	2260007005	1.38	1.91	Employment - MASER
4-Stroke Gasoline				
Trimmers/Edgers/Brush Cutters	2265004025	1.39	1.98	Employment - 71
Lawn Mowers	2265004010	1.15	1.34	Dev Land MAG /less grass lawns
Leaf Blowers/Vacuums	2265004030	1.39	1.98	Employment - 71
Rear Engine Riding Mowers	2265004040	1.15	1.34	Dev Land MAG /less grass lawns
Front Mowers	2265004045	1.15	1.34	Dev Land MAG /less grass lawns
Shredders <5 HP	2265004050	1.00	1.00	LITTLE USE
Tillers <5 HP	2265004015	1.00	1.00	LITTLE USE
Lawn & Garden Tractors	2265004055	1.15	1.34	Dev Land MAG /less grass lawns
Wood Splitters	2265004060	1.00	1.00	LITTLE USE
Chippers/Stump Grinders	2265004065	1.00	1.00	LITTLE USE
Commercial Turf Equipment	2265004070	1.39	1.98	Employment - 71
Other Lawn & Garden Equipment	2265004075	1.15	1.34	Dev Land MAG /less grass lawns
Aircraft Support Equipment	2265008005	1.24	1.46	Carrier ops
Terminal Tractors	2265008010	1.24	1.46	Carrier ops
All Terrain Vehicles (ATVs)	2265001030	0.85	0.65	Undev Land MAG
Minibikes	2265001040	0.85	0.65	Undev Land MAG
Off-Road Motorcycles	2265001010	0.85	0.65	Undev Land MAG
Golf Carts	2265001050	1.38	1.91	Employment - MASER
Specialty Vehicles Carts	2265001060	1.38	1.91	Employment - MASER
Generator Sets <50 HP	2265006005	1.13	1.33	Employment - MAN+CON
Pumps <50 HP	2265006010	1.13	1.33	Employment - MAN+CON
Air Compressors <50 HP	2265006015	1.13	1.33	Employment - MAN+CON
Welders <50 HP	2265006025	1.13	1.33	Employment - MAN+CON

2006 and 2015 NONROAD EQUIPMENT CO GROWTH FACTORS				
Nonroad Equipment Type	ASC Code	2006 GF	2015 GF	Growth Reference
Pressure Washers <50 HP	2265006030	1.13	1.33	Employment - MAN+CON
Aerial Lifts	2265003010	1.22	1.50	Employment - MAN+MIN+TRD
Forklifts	2265003020	1.22	1.50	Employment - MAN+MIN+TRD
Sweepers/Scrubbers	2265003030	1.22	1.50	Employment - MAN+MIN+TRD
Other General Industrial Equipment	2265003040	1.22	1.50	Employment - MAN+MIN+TRD
Other Material Handling Equipment	2265003050	1.22	1.50	Employment - MAN+MIN+TRD
Asphalt Pavers	2265002003	1.15	1.47	Employment - CON
Tampers/Rammers	2265002006	1.15	1.47	Employment - CON
Plate Compactors	2265002009	1.15	1.47	Employment - CON
Rollers	2265002015	1.15	1.47	Employment - CON
Paving Equipment	2265002021	1.15	1.47	Employment - CON
Surfacing Equipment	2265002024	1.15	1.47	Employment - CON
Signal Boards	2265002027	1.15	1.47	Employment - CON
Trenchers	2265002030	1.15	1.47	Employment - CON
Bore/Drill Rigs	2265002033	1.15	1.47	Employment - CON
Concrete/Industrial Saws	2265002039	1.15	1.47	Employment - CON
Cement and Mortar Mixers	2265002042	1.15	1.47	Employment - CON
Cranes	2265002045	1.15	1.47	Employment - CON
Crushing/Proc. Equipment	2265002054	1.15	1.47	Employment - CON
Rough Terrain Forklifts	2265002057	1.15	1.47	Employment - CON
Rubber Tired Loaders	2265002060	1.15	1.47	Employment - CON
Tractors/Loaders/Backhoes	2265002066	1.15	1.47	Employment - CON
Skid Steer Loaders	2265002072	1.15	1.47	Employment - CON
Dumpers/Tenders	2265002078	1.15	1.47	Employment - CON
Other Construction Equipment	2265002081	1.15	1.47	Employment - CON
2-Wheel Tractors	2265005010	0.74	0.42	Ag stats
Agricultural Tractors	2265005015	0.74	0.42	Ag stats
Agricultural Mowers	2265005030	0.74	0.42	Ag stats
Combines	2265005020	0.74	0.42	Ag stats
Sprayers	2265005035	0.74	0.42	Ag stats
Tillers >5 HP	2265005040	0.74	0.42	Ag stats
Swathers	2265005045	0.74	0.42	Ag stats
Hydro Power Units	2265005050	0.74	0.42	Ag stats
Other Agricultural Equipment	2265005055	0.74	0.42	Ag stats
Diesel				
Rear Engine Riding Mowers	2270004040	1.15	1.34	Dev Land MAG /less grass lawns
Lawn & Garden Tractors	2270004055	1.15	1.34	Dev Land MAG /less grass lawns
Wood Splitters	2270004060	1.00	1.00	LITTLE USE
Chippers/Stump Grinders	2270004065	1.00	1.00	LITTLE USE
Commercial Turf Equipment	2270004070	1.39	1.98	Employment - 71
Other Lawn & Garden Equipment	2270004075	1.15	1.34	Dev Land MAG /less grass lawns
Aircraft Support Equipment	2270008005	1.24	1.46	Carrier ops
Terminal Tractors	2270008010	1.24	1.46	Carrier ops
Specialty Vehicles Carts	2270001060	1.38	1.91	Employment - MASER
Generator Sets <50 HP	2270006005	1.13	1.33	Employment - MAN+CON
Pumps <50 HP	2270006010	1.13	1.33	Employment - MAN+CON
Air Compressors <50 HP	2270006015	1.13	1.33	Employment - MAN+CON

2006 and 2015 NONROAD EQUIPMENT CO GROWTH FACTORS
(Continued)

Nonroad Equipment Type	ASC Code	2006 GF	2015 GF	Growth Reference
Welders <50 HP	2270006025	1.13	1.33	Employment - MAN+CON
Pressure Washers <50 HP	2270006030	1.13	1.33	Employment - MAN+CON
Aerial Lifts	2270003010	1.22	1.50	Employment - MAN+MIN+TRD
Forklifts	2270003020	1.22	1.50	Employment - MAN+MIN+TRD
Sweepers/Scrubbers	2270003030	1.22	1.50	Employment - MAN+MIN+TRD
Other General Industrial Equipment	2270003040	1.22	1.50	Employment - MAN+MIN+TRD
Other Material Handling Equipment	2270003050	1.22	1.50	Employment - MAN+MIN+TRD
Asphalt Pavers	2270002003	1.15	1.47	Employment - CON
Plate Compactors	2270002009	1.15	1.47	Employment - CON
Concrete Pavers	2270002012	1.15	1.47	Employment - CON
Rollers	2270002015	1.15	1.47	Employment - CON
Scrapers	2270002018	1.15	1.47	Employment - CON
Paving Equipment	2270002021	1.15	1.47	Employment - CON
Signal Boards	2270002027	1.15	1.47	Employment - CON
Trenchers	2270002030	1.15	1.47	Employment - CON
Bore/Drill Rigs	2270002033	1.15	1.47	Employment - CON
Excavators	2270002036	1.15	1.47	Employment - CON
Concrete/Industrial Saws	2270002039	1.15	1.47	Employment - CON
Cement and Mortar Mixers	2270002042	1.15	1.47	Employment - CON
Cranes	2270002045	1.15	1.47	Employment - CON
Graders	2270002048	1.15	1.47	Employment - CON
Off-Highway Trucks	2270002051	1.15	1.47	Employment - CON
Crushing/Proc. Equipment	2270002054	1.15	1.47	Employment - CON
Rough Terrain Forklifts	2270002057	1.15	1.47	Employment - CON
Rubber Tired Loaders	2270002060	1.15	1.47	Employment - CON
Rubber Tired Dozers	2270002063	1.15	1.47	Employment - CON
Tractors/Loaders/Backhoes	2270002066	1.15	1.47	Employment - CON
Crawler Tractors	2270002069	1.15	1.47	Employment - CON
Skid Steer Loaders	2270002072	1.15	1.47	Employment - CON
Off-Highway Tractors	2270002075	1.15	1.47	Employment - CON
Dumpers/Tenders	2270002078	1.15	1.47	Employment - CON
Other Construction Equipment	2270002081	1.15	1.47	Employment - CON
Agricultural Tractors	2270005015	0.74	0.42	Ag stats
Combines	2270005020	0.74	0.42	Ag stats
Sprayers	2270005035	0.74	0.42	Ag stats
Balers	2270005025	0.74	0.42	Ag stats
Swathers	2270005045	0.74	0.42	Ag stats
Hydro Power Units	2270005050	0.74	0.42	Ag stats
Other Agricultural Equipment	2270005055	0.74	0.42	Ag stats

ATTACHMENT FOUR

Land Use Growth Factors

Procedure to Obtain Growth Factors for Off-Road Vehicles & Lawn/Garden Equipment

1. For the 1990 land use cover, add together the following Land Use Categories which occur inside the CO nonattainment area boundary: 1-5, 8, 16-22, 27-28. This represents the Lawn/Garden acreage for 1990.

2. For the 1990 land use cover, determine the acres in Land Use Category 31 - Vacant Desert in the CO nonattainment area. This represents the Off-Road Vehicle acreage for 1990.

3. For the 1995 land use cover, add together the following Land Use Categories inside the CO nonattainment area: 1-5, 9, 14-16, 20. This represents the Lawn/Garden acreage for 1995.

4. For the 1995 land use cover, determine the acres in Land Use Category 24 - Vacant, in the CO nonattainment area. This represents the Off-Road Vehicle acreage for 1995.

5. Calculate the Lawn/Garden and the Off-Road Vehicle growth factors: (1995-1990)/1990.

6. Extrapolate the growth factors to 2015

Calculation of Annual Growth for Lawn/Garden and Off-road Vehides

Category	1990 acres	1995 acres	1990 to 1995 growth factor	annual growth
lawn/garden	357,937	404,452	1.12995	0.02599
off-road vehicles	524,125	476,545	0.90922	-0.01816

Projection Factors for Lawn/Garden and Off-road Vehicles

Year	unadjusted lawn/garden projection factor	adjusted lawn/garden projection factor	off-road vehicle projection factor
1990	1.00000	1.00000	1.00000
1991	1.02599	1.00137	0.98184
1992	1.05198	1.02673	0.96368
1993	1.07797	1.05210	0.94552
1994	1.10396	1.07746	0.92736
1995	1.12995	1.10283	0.90920
1996	1.15594	1.12820	0.89104
1997	1.18193	1.15356	0.87288
1998	1.20792	1.17893	0.85472
1999	1.23391	1.20430	0.83656
2000	1.25990	1.22966	0.81840
2001	1.28589	1.25503	0.80024
2002	1.31188	1.28039	0.78208
2003	1.33787	1.30576	0.76392
2004	1.36386	1.33113	0.74576
2005	1.38985	1.35649	0.72760
2006	1.41584	1.38186	0.70944
2007	1.44183	1.40723	0.69128
2008	1.46782	1.43259	0.67312

Year	unadjusted lawn/garden projection factor	adjusted lawn/garden projection factor	off-road vehicle projection factor
2009	1.49381	1.45796	0.65496
2010	1.51980	1.48332	0.63680
2011	1.54579	1.50869	0.61864
2012	1.57178	1.53406	0.60048
2013	1.59777	1.55942	0.58232
2014	1.62376	1.58479	0.56416
2015	1.64975	1.61016	0.54600

1990 Land Use Categories		1995 Land Use Categories	
1	Low Density Residential	1	Rural
2	Medium Density Residential	2	Large Lot Residential
3	High Density Residential	3	Small Lot Residential
4	Mobile Homes and RV Parks	4	Medium Density Residential
5	Medium Residential Under Development	5	High Density Residential
6	Low Density Commercial	6	Neighborhood Retail Centers
7	Medium Density Commercial	7	Commercial Retail Centers
8	Hotel, Resort	8	Regional Retail Centers
9	Regional Shopping Center	9	Hotel, Resort
10	Commercial Warehouse	10	Warehouse District
11	Neighborhood Office Buildings	11	Industrial
12	High-Rise Office Buildings	12	Business Parks
13	Light Industrial	13	Office Buildings
14	General industrial	14	Education
15	Unknown	15	Institution
16	Institution - Schools	16	Public Facilities
17	Institution - Colleges	17	Large Assembly Areas
18	Institution - Universities	18	Transportation
19	Institution - Small hospitals	19	Airports
20	Institution - Large Hospitals	20	Recreation/Open Space
21	Institution - Public Facilities	21	Nondevelopable Open Space
22	Institution - Churches	22	Water
23	Power Stations	23	Agriculture
24	Railroads and Rail Yards	24	Vacant
25	Airports		
26	Freeways, Canals, Dams		
27	Parks		
28	Golf Courses		
29	Lakes		
30	Rivers		
31	Vacant - Desert		
32	Agriculture - Citrus		
33	Agriculture - Other Crops		
34	Agriculture - Stockyards		
35	Unknown		
36	Unknown		
37	Unknown		
38	Unknown		
39	Unknown		
40	Nondevelopable - Other		
41	Nondevelopable - Forest		
42	Nondevelopable - Mountain Range		
43	Nondevelopable - Gunnery Range		

App.VII-iv

Committed Maintenance Measures

COMMITTED MAINTENANCE MEASURE #1

Winter Fuel Reformulation: California Phase 2 Reformulated Gasoline with 3.5 Percent Oxygen Content November 1 Through March 31

September 4, 2002

The “Winter Fuel Reformulation California Phase 2 Reformulated Gasoline with 3.5 Percent Oxygen Content November 1 Through March 31" measure affects nonroad emissions from gasoline-powered engines and emissions from onroad vehicle gasoline-powered engines. With the implementation of this measure, a cleaner burning formulation of gasoline than would otherwise be used will be sold in the nonattainment area during the CO season. The methodology used to estimate the CO benefit for nonroad source categories is described below. In this analysis, all onroad credit for committed measure package gasoline is applied using the MOBILE6 model.

To estimate the effect of the expected gasoline formulation on onroad emissions, the MOBILE6 model was used. MOBILE6 accepts as input data for the gasoline vapor pressure (RVP), oxygenate content, and sulfur content. The MOBILE6 model runs performed for this analysis incorporate the committed maintenance measure package RVP value, oxygenate content and market share, and gasoline sulfur content. To estimate the effect of the cleaner burning gasoline, MOBILE6 was performed using both the committed measure package and the base case (1994 conditions) formulations. The emissions estimated by the two runs were processed through the M6Link program independently and the difference in final emissions estimates was calculated.

To estimate the fractional reduction on nonroad engines, the methodology was different. Specifically, the emissions reduction from cleaner burning gasoline is split into two parts, the introduction of oxygenate into the gasoline supply at 100 percent ethanol market share and 3.5 percent by volume and the subsequent introduction of reformulated gasoline.

The credit for the reformulated gasoline was applied to the base year inventory by Maricopa County although the credit for the oxygenated gasoline was not. The Maricopa County 1999 base year inventory was the basis for nonroad emission totals developed in the future year by MAG. For the purposes of this analysis, only credit for the oxygenated gasoline was applied in order to not double count credit for reformulated gasoline.

The magnitude of the benefit from the use of oxygenated gasoline with a 100 percent market share for ethanol and 3.5 percent by volume was estimated with a run of the EPA MOBILE5a model. The credit was compared versus a base case gasoline that reflected the 1994 base year conditions. In the 1994 conditions, the gasoline was assumed to contain MTBE at a 17 percent market share at 2.5 percent by volume and the remaining 83 percent of the market share contained ethanol at 3.5 percent by volume.

The MOBILE5a run was performed reflecting a 1970 scenario at a typical speed and temperature. The year 1970 was chosen because onroad vehicles being driven during that time period would more closely resemble nonroad vehicles of today from an emissions control technology standpoint than more modern vehicles. The emission rate output by the MOBILE5a program with the base case oxygenate content was 71.70 versus a rate of 70.59 for the committed measures package oxygen content. The effect of the change in the oxygenate content was a reduction in carbon monoxide emissions of 1.16 percent.

The nonroad reduction was applied through the use of a /PROJECT AMS/ packet that applied a 0.984 factor to all 2260XXXXXX and 2265XXXXXX ASC codes.

COMMITTED MAINTENANCE MEASURE #2

Phased-In Emission Test Cutpoints

September 5, 2002

The “Phased-In Emission Test Cutpoints” measure affects onroad emissions. With the implementation of this measure, vehicles which are subject to the enhanced I/M program are held to a stricter set of cutpoints than would otherwise be the case. The stricter cutpoints were implemented in January 2000. If a vehicle exceeds the emission levels set by the cutpoint for carbon monoxide, hydrocarbons, or NOx, the vehicle fails the test.

The Arizona Department of Environmental Quality (ADEQ) provided a table of emission testing cutpoints for each model year vehicle subject to the enhanced I/M program in the May 28, 2001 ADEQ memo Cutpoints for IM147 for MOBILE6. These cutpoints are entered into a data file in a format appropriate for input to the MOBILE6 model. The format for the table appropriate for input to MOBILE6 may be found in section 2.8.9.4.g of the User’s Guide to MOBILE6.0 Mobile Source Emission Factor Model, EPA420-R-02-001, January 2002.

The phase 2 test cutpoints (I/M147 program) that reflect the enhanced program are indicated in the following table. The LDGV cutpoints were used in the MOBILE6 Block 1 cutpoint values. The LDGT1 cutpoints were used in Block 2. The LDGT2 cutpoints were used in Blocks 3 and 4.

Model Year	Vehicle Class	Hydrocarbons	CO	NOx
1981-1982	LDGV	2.50	21.80	3.40
1983-1985	LDGV	2.00	17.30	3.40
1986-1989	LDGV	1.40	12.80	2.40
1990-1993	LDGV	0.80	10.10	2.40
1994+	LDGV	0.70	10.10	1.90
1981-1985	LDGT1	3.40	35.30	5.40
1986-1989	LDGT1	2.50	21.80	4.40
1990-1993	LDGT1	1.70	17.30	3.90
1994+	LDGT1	1.40	17.30	2.90
1981-1985	LDGT2	3.70	42.50	6.90
1986-1987	LDGT2	3.40	35.30	5.40
1988-1989	LDGT2	2.50	21.80	5.40
1990-1993	LDGT2	2.50	21.80	4.90
1994+	LDGT2	2.00	21.80	3.90

While the previous table lists the cutpoints used for model years back to 1981, due to the structure of MOBILE6, only the cutpoints back to the model year 1992 are considered when performing a December 2015 run. Similarly, only the cutpoints back to the model year 1983 are considered when performing a December 2006 run. This is because the MOBILE6 model only considers the most recent 25 model years in any particular run. In December 2015, the 25th model year included in the modeling is a 1992 vehicle.

The following table indicates the base case cutpoints as used in the I/M240 program, based upon Appendix A Failure Rate Analysis and Development of Fast-Pass, Retest, and CPP Algorithms for IM147 Max CO Cutpoints, Sierra Research, December 14, 1999.

Model Year	Vehicle Class	Hydrocarbons	CO	NOx
1981-1982	LDGV	2.00	60.0	3.0
1983-1985	LDGV	2.00	30.0	3.0
1986-1990	LDGV	2.00	30.0	3.0
1991-1993	LDGV	1.20	20.0	2.5
1994-1995	LDGV	1.20	20.0	2.5
1996+	LDGV	0.80	15.0	2.0
1981-1983	LDGT1	7.50	100.0	7.0
1984-1985	LDGT1	3.20	80.0	7.0
1986-1987	LDGT1	3.20	80.0	7.0
1988-1990	LDGT1	3.20	80.0	3.5
1991-1993	LDGT1	2.40	60.0	3.0
1994-1995	LDGT1	2.40	60.0	3.0
1996+	LDGT1	1.00	20.0	2.5
1981-1983	LDGT2	7.50	100.0	7.0
1984-1986	LDGT2	3.20	80.0	7.0
1987	LDGT2	3.20	80.0	7.0
1988-1990	LDGT2	3.20	80.0	5.0
1991-1993	LDGT2	2.40	60.0	4.5
1994-1995	LDGT2	2.40	60.0	4.5
1996+	LDGT2	2.40	60.0	4.0

The benefit from the stricter cutpoints was estimated by running the M6Link model with the MOBILE6 outputs developed using the base case cutpoints and then rerunning M6Link with the MOBILE6 outputs developed using the stricter cutpoints. In both cases, MOBILE6 was run with a five year grace period from the I/M program for the newest model year vehicles.

COMMITTED MAINTENANCE MEASURE #3

One Time Waiver from Vehicle Emissions Test

July 23, 2002

The “One Time Waiver from Vehicle Emissions Test” measure affects onroad emissions. With the implementation of this measure, vehicles are allowed no more than a single I/M waiver after January 1, 1997. The methodology used to estimate the emissions reduction is described below.

MOBILE6 uses as input the waiver rates for two age groups of vehicles. The first age group is vehicles of model years before 1981. The second age group is vehicles of model years 1981 and newer. It is assumed that absent this control measure, the waiver rate for pre-1981 model year vehicles would be four percent and the waiver rate for model year vehicles 1981 and newer would be three percent. The base case waiver rates incorporate no set limit on the number of waivers which a given vehicle may receive. This measure sets a limit of one on the number of waivers which any vehicle may receive.

It has been estimated that the average remaining life span of a vehicle which has received a waiver is three years (page E-5 of <u>Feasibility and Cost-Effective Study of New Air Pollution Control Measures Pertaining to Mobile Sources</u>, Sierra Research, Inc., June 1993). It was assumed that the 1994 base case run includes the three-year life after waiver implicitly through the MOBILE6 waiver rates of 4 percent and 3 percent. This measure effectively reduces that three-year life to one year, and result in approximately two thirds of the reductions of a change to zero waivers. With the implementation of this control measure, the waiver rate for pre-1981 model year vehicles would be one and one third percent and the waiver rate for model year vehicles 1981 and newer would be one percent.

The base case input to MOBILE6 of four percent waivers for pre-1981 model year vehicles was changed to one 1.3 percent to reflect this measure. The base case input to MOBILE6 of three percent waivers for 1981 and newer model year vehicles was changed to one percent to reflect this measure.

COMMITTED MAINTENANCE MEASURE #4

Defer Emissions Associated with Government Activities

April 14, 2000

The “Defer Emissions Associated with Government Activities” measure affects nonroad mobile emissions. With this measure, the operation of two-stroke gasoline powered equipment (e.g., lawn and garden equipment) used by government agencies will be reduced after 2:00 p.m. Only a temporal shift in emissions is expected from this measure. The methodology used to estimate the impact of the temporal shift in emissions is described below.

Based on information obtained from government agencies in Maricopa County, it was estimated that approximately six percent of two-stroke gasoline powered nonroad emissions occurring after 2:00 p.m. will be shifted to between 6:00 a.m. and 2:00 p.m. This measure was modeled in the TMPRL module of EPS2.0. The TMPRL module is able to allocate emissions to specific hours of the day.

Based on these assumptions, the temporal profile that was used for input into the TMPRL module of EPS2.0 reflects a six percent decrease in emissions from the 2-stroke gasoline powered engines after 2:00 p.m. The emissions removed from the 2:00 p.m. to 12:00 a.m. period were equally distributed to each hour in the 6:00 a.m. to 2:00 p.m. period in the new temporal profile. Table 1 shows the percentage of emissions allocated to each hour for the base case and committed measure case for each nonroad engine category affected by the measure. Note that not all nonroad two-stroke gasoline emissions are affected by this measure; for example, government agencies are assumed to not operate farming equipment, airport support equipment, or logging equipment.

Table 1. Percentage of Daily Emissions Occurring in Each Hour for the Base Case and the Committed Measure Package (CMP) Case

	Nonroad Engine Category									
	Recreational		Lawn and Garden		Construction		Light Industrial		Commercial	
Hour	Base	CMP	Base	CMP	Base	CMP	Base	CMP	Base	CMP
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30
5	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30
6	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30
7	0.00	0.00	0.00	0.00	0.00	0.00	5.09	5.29	5.09	5.29
8	9.09	9.38	0.00	0.00	7.69	8.11	5.09	5.29	5.09	5.29
9	9.09	9.38	0.00	0.00	7.69	8.11	5.09	5.29	5.09	5.29
10	9.09	9.38	12.50	12.98	7.69	8.11	8.48	8.88	8.48	8.88
11	9.09	9.38	12.50	12.98	7.69	8.11	8.48	8.88	8.48	8.88
12	9.09	9.38	12.50	12.98	7.69	8.11	8.48	8.88	8.48	8.88
13	9.09	9.38	12.50	12.98	7.69	8.11	8.48	8.88	8.48	8.88
14	9.09	9.38	12.50	12.98	7.69	8.11	8.48	8.88	8.48	8.88
15	9.09	8.58	12.50	11.69	7.69	7.21	8.48	7.98	8.48	7.98
16	9.09	8.58	12.50	11.69	7.69	7.21	8.18	7.68	8.18	7.68
17	9.09	8.58	12.50	11.69	7.69	7.21	8.18	7.68	8.18	7.68
18	9.09	8.58	0.00	0.00	7.69	7.21	8.18	7.68	8.18	7.68
19	0.00	0.00	0.00	0.00	7.69	7.21	2.79	2.59	2.79	2.59
20	0.00	0.00	0.00	0.00	7.69	7.21	2.79	2.59	2.79	2.59
21	0.00	0.00	0.00	0.00	0.00	0.00	2.79	2.59	2.79	2.59
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

COMMITTED MAINTENANCE MEASURE #5

Coordinate Traffic Signal Systems

July 23, 2002

The “Coordinate Traffic Signal Systems” measure affects onroad emissions. With the implementation of this measure, vehicles in the modeling area spend less time idling at traffic lights than is assumed in the base case. The methodology used to estimate the emissions reduction is described below.

This measure affects onroad CO emissions through a reduction in idling time at traffic signals. The estimation of the benefit from the measure involves the estimation of three factors, which were multiplied together to estimate a total emission reduction.

The three factors involved in the calculation of the benefit from this measure are as follows:

- The CO idling emission rate per hour from an average onroad vehicle,
- The reduction in idle time per intersection, and
- The total number of intersections which will be affected by this measure.

Estimate of the CO idling emission rate per hour from an average onroad vehicle

The average CO idling rate was estimated using MOBILE6. Two MOBILE6 runs were performed, reflecting I/M and non-I/M. One vehicle speed, 2.5 miles per hour was used. Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, EPA, January 2002 recommends running the mobile model at a speed of 2.5 miles per hour since the mobile model does not calculate idle emissions directly. The output from MOBILE6, in units of grams per mile, was converted to the desired units of grams per hour by multiplication of 2.5 miles per hour.

Hourly temperatures were input, from which MOBILE6 calculated the ambient daily temperature internally. The I/M and non-I/M results were weighted (0.916 for I/M and 0.084 non-I/M) to determine the net emission rate. The MOBILE6 calculated emission rates are shown in the following table.

	I/M with waivers	non-IM	Net
Emission rate (grams per mile) 2015	18.052	23.453	18.51
Weighting Fraction	0.916	0.084	1.000

The net emission rate of 18.51 grams per mile, or 46.3 grams per hour was obtained from the weighting of the emission rates.

Estimate of reduction in idle time per intersection

The amount of vehicle idling time per intersection saved with implementation of the measure was estimated using data from the Final Report of the Governor's Alternative Transportation System Task Force, November 1996. That report referenced a study which estimated that, on average, 16,366 hours of delay per intersection would be saved through enhanced traffic signal coordination. This annual benefit was calculated with the assumption that retiming primarily affects weekday time periods other than late at night. With approximately 260 weekdays per year, 16,366 hours of delay per year equates to approximately 62.9 hours of delay per weekday.

Estimate of the total number of intersections which will be affected by this measure

It is assumed that 661 intersections will be upgraded in the CO modeling area as a result of this measure. The net results are a total reduction of 1.93 metric tons per day, as calculated below.

Estimate of the Total Emission Reduction

$$\frac{46.3\ \text{grams}}{\text{hour}} \times \frac{62.9\ \text{hours}}{\text{intersection}} \times 661\ \text{intersections} \times \frac{1\ \text{metric ton}}{1 \times 10^{6}\ \text{grams}} = \frac{1.93\ \text{metric tons}}{\text{day}}$$

This measure was not modeled through the M6Link program, but as a post-processing measure to M6Link. The net emissions reduction in metric tons resulting from this control measure was estimated using the method described above. The net reduction was compared to the total onroad emissions, estimated before post-processing, output by the M6Link model. The fractional reduction in the total emissions from M6Link resulting from this control measure was applied to the M6Link output using the M6Link utility program. A similar methodology was used for the 2006 analysis.

COMMITTED MAINTENANCE MEASURE #6

Develop Intelligent Transportation Systems

September 5, 2002

The “Develop Intelligent Transportation Systems” measure affects onroad emissions. With the implementation of this measure, vehicles in the modeling area will spend less time idling at traffic lights and will be better able to avoid traffic congestion than is assumed in the base case. The methodology used to estimate the emissions reduction is described below.

This measure affects net CO emissions through three improvements to the transportation system. These three changes are an improvement of traffic signal coordination, the installation of ITS instrumentation along eight arterial corridors, and the addition of 33 centerline miles of freeway into the freeway management system (FMS).

The average CO emission rates were estimated using the EPA MOBILE6 model (MOBILE6). Two MOBILE6 runs were performed, reflecting I/M and non-I/M. Both runs were consistent with the base MOBILE6 runs input to M6Link, except for vehicle speed and roadway types were set to be appropriate for this ITS analysis. The output format was changed from database format to a text format because an overall fleetwide emission factor was needed rather than a detailed breakdown of emission rates by vehicle age and type. Several vehicle speeds were processed, including a speed used to calculate the idle emission rate. Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, EPA, January 2002 recommends running the mobile model at a speed of 2.5 miles per hour since the mobile model does not calculate idle emissions directly. The output from MOBILE6, in units of grams per mile, was converted to the desired units of grams per hour by multiplication of 2.5 miles per hour.

Hourly temperatures were input, from which MOBILE6 calculated the ambient daily temperature internally. The I/M and non-I/M results were weighted (0.916 for I/M and 0.084 non-I/M) to determine the net emission rate. The MOBILE6 calculated emission rates are shown in the following table. All units are in grams per mile except for the Total Idle emission rate which is in grams per hour.

Speed	I/M	non-I/M	Total
Idle (2.5)	18.052 g/mi	23.453 g/mi	46.3 *g/hr*
20.0	7.656 g/mi	9.149 g/mi	7.78 g/mi
23.9	7.413 g/mi	8.819 g/mi	7.53 g/mi
30.3	7.227 g/mi	8.550 g/mi	7.34 g/mi
33.3	7.235 g/mi	8.549 g/mi	7.35 g/mi
Weighting-->	0.916	0.084	1.000

Traffic Signal Coordination

It is assumed that 95 traffic signals, in addition to the 661 traffic signals modeled for the Coordinate Traffic Signal Systems measure, will be enhanced as a result of this measure. The methodology developed for the Coordinate Traffic Signal Systems measure was followed in the modeling of this measure, resulting in an emissions reduction of 0.28 metric tons in 2015.

$$95 \text{ intersections} \times \frac{62.9 \text{ hours}}{\text{Intersection}} \quad \frac{46.3 \text{ grams}}{\text{hour}} \times \frac{1 \text{ metric ton}}{1 \times 10^6 \text{ grams}} = \frac{0.28 \text{ metric tons}}{\text{day}}$$

Additional details of the analysis of the traffic signal coordination measure and modeling methodology may be found in the previous measure description for Committed Maintenance Measure #5, Traffic Light Synchronization.

Installation of ITS through the AzTECH program

This portion of the ITS measure affects net CO emissions through an increase in average vehicle speeds. The installation of ITS alerts drivers of congestion incidents, permitting efficient rerouting of traffic and increasing vehicle speeds. The average, per vehicle-mile, change in emission rates from the speed increase was estimated using MOBILE6. The change in per vehicle-mile emissions was multiplied by the vehicle miles traveled on each affected facility type to estimate the net change in emissions.

Four vehicle speeds were processed, reflecting data in the Final Report of the Governor's Alternative Transportation System Task Force. These speeds are 30.3 and 20 miles per hour, reflecting arterial speeds with and without implementation of the measure and 33.3 and 23.9 miles per hour, reflecting freeway speeds with and without the measure.

The Governor's Alternative Transportation System Task Force estimates that two congested miles per vehicle on arterials and two congested miles per vehicle on freeways could be avoided per congestion incident with the system. Combining the emission rate savings estimated with MOBILE6 with congested mileage savings estimated by the Task Force, the following pollution change was estimated per vehicle:

$$\frac{2 \text{ art. Miles}}{\text{Vehicle}} \times \frac{(7.78 - 7.34) \text{ grams}}{\text{Mile}} + \frac{2 \text{ fwy. Miles}}{\text{Vehicle}} \times \frac{(7.53 - 7.35) \text{ grams}}{\text{Mile}} = 1.24 \text{ gm/veh. CO}$$

Rerouting of vehicles was estimated to increase average vehicle trip length by 0.6 miles on non-congested arterials. This increase in trip length would offset the previously calculated emission changes by:

$$\frac{0.6 \text{ arterial miles}}{\text{Vehicle}} \times \frac{7.34 \text{ grams}}{\text{Mile}} = 4.40 \text{ grams/vehicle CO}$$

The result was a net emission increase of 3.16 grams of CO per vehicle. The Governor's Alternative Transportation System Task Force estimates that the average congestion incident affects 9960 vehicles and that the 100 affected arterials (150 additional freeway miles with one arterial every 1.5 miles) each have an average of 1.5 incidents per 5 weekdays. The estimate of 150 additional freeway miles of instrumentation (equivalent to 100 arterials) is a conservative one because nearly 150 miles of arterial streets in eight "smart" corridors were complete by 1999. The estimate of 0.075 incidents per mile-day is based upon estimates in the Governor's Alternative Transportation System Task Force report which indicates that of 133 instrumented arterials, there are 0.3 incidents per day, covering 532 center lane miles, and therefore...

$$\underline{133 \text{ arterials}} \times \frac{0.3 \text{ incidents}}{\text{Day}} \times \frac{1}{532 \text{ CL miles}} = \frac{0.075 \text{ incidents}}{\text{Mile-day}}$$

The estimated pollution reduction per incident is:

$$\frac{9960 \text{ vehicles}}{\text{incident}} \quad X \quad \frac{3.16 \text{ grams CO reduction}}{\text{Vehicle}} = \frac{31.5 \text{ kg CO increase}}{\text{Incident}}$$

The final estimated increase from this portion of the measure is 0.35 metric tons per day.

$$\frac{150 \text{ mile}}{} \ X \ \frac{.075 \text{ incidents}}{\text{mile - day}} \ X \ \frac{31.3 \text{ kg CO}}{\text{Incident}} \ X \ \frac{1 \text{ metric ton}}{1000 \text{ kg}} = \frac{0.35 \text{ metric tons}}{\text{Day}}$$

Freeway Management System Expansion

The addition of 33 centerline miles of freeway into the freeway management system is assumed to result from this measure. The methodology developed in the document Feasibility and Cost Effectiveness of New Air Pollution Control Measures Pertaining to Mobile Sources, Sierra Research, June 1993 were followed in the modeling of this measure. Sierra Research estimated that each freeway mile of ITS would result in a reduction of 22.53 kg per mile in 1995 and 35.20 kg per mile in 2005. It is assumed that the Sierra estimate for 2005 is a conservatively low estimate for the benefit in 2015.

This reduction was adjusted by factors of 0.966 (lower RVP), 0.935 (increased oxygen), and 0.85 (rough estimate of IM and other measures benefit) to take into account influences on emission rates which have occurred since the Sierra Research report was completed. For 2015, the reduction of 27.0 kilograms per mile [35.20 * 0.966 * 0.935 * 0.85] was combined with the 33 miles of freeway resulting in an emissions reduction of 0.89 metric tons per day before post-processing. The same benefit is assumed for the CO Maintenance Plan modeling for 2015. This is likely a conservative estimate of benefits because the Sierra evaluation indicated an increasing level of benefit over time and because the number of miles of freeway incorporated into the FMS system is assumed to be greater than 33 in 2015.

Summary

These three improvements sum to a net reduction of 0.82 metric tons per day. This emission reduction was applied across the board. It is important to note that the reductions assumed for each component of the control measure are added together linearly since the benefit is generally applied to different roadways.

Part of Measure	Benefit (met. tons)
Traffic Signal	0.28
AzTECH Program	-0.35
FMS	0.89
Total	0.82

This measure was not modeled through the M6Link program, but as a post-processing measure to M6Link. The net emissions reduction in metric tons resulting from this control measure was estimated using the method described above. The net reduction was compared to the total onroad emissions, estimated before post-processing, output by the M6Link model. The fractional reduction in the total emissions from M6Link resulting from this control measure was applied to the M6Link output using the EMSCOR utility program. The calculations described above reflected the 2015 scenario. The 2006 scenario was modeled using the same overall methodology.

COMMITTED MAINTENANCE MEASURE #7

Tougher Enforcement of Vehicle Registration and Emission Test Compliance

July 23, 2002

The “Tougher Enforcement of Vehicle Registration and Emission Test Compliance” measure affects onroad emissions. With the implementation of this measure, the number of vehicles which are expected to be registered in the nonattainment area and tested in the I/M program is increased, resulting in a cleaner onroad vehicle fleet. The methodology used to estimate the emissions reduction is described below.

Without this control measure, the weighting of I/M versus non-I/M emission factors from the EPA MOBILE6 model (MOBILE6) was assumed to be 89.6 percent I/M and 10.4 percent non-I/M. The weighting factors are an input to the M6Link control file. This measure was modeled by adjusting the weighting between I/M and non-I/M emission factors from MOBILE6.

The Report of the Governor’s Air Quality Strategies Task Force, December 2, 1996 estimated that an additional 41,000 vehicles would be emission tested as a result of this measure. This estimate was confirmed with the Arizona Department of Environmental Quality and the Arizona Department of Transportation as being a reasonable, and perhaps conservative, estimate of the number of vehicles registered as a result of this measure.

This measure was modeled for CO by an adjustment of the weighting between I/M and non-I/M emission factors from MOBILE6. The number of vehicles registered in Maricopa County is during the time of the Task Force estimate was approximately 1.83 million. The inspection of an additional 41,000 vehicles would be an additional 2.0 percent of the vehicles being emissions tested. It is assumed that the increase in the vehicles being emission tested, taken as a fraction, would remain constant or increase over time. The number of vehicles which participate in the I/M program was increased by 2.0 percent for the 2015 analysis, changing the weighting from 89.6/10.4 to 91.6/8.4.

COMMITTED MAINTENANCE MEASURE #8

MAG Clean Burning Fireplace Ordinance

March 26, 2003

The “MAG Clean Burning Fireplace Ordinance” measure, which is related to 97-FP-1, affects area source emissions. With the implementation of this measure, wood burning devices constructed or installed beginning in 1999 are required to be “low-emitters” or EPA-certified Phase II or equivalent. Based on the MAG residential wood combustion survey conducted for the 1994 PM-10 Inventory, 28 percent of residences have fireplaces and one percent have wood stoves. Fireplace and wood stove population estimates were derived by combining the aforementioned percentages with the estimated number of residences in the CO Nonattainment Area.

In order to estimate the change in emissions resulting from implementation of the MAG clean burning fireplace ordinance in 2006 and 2015, the fireplace/wood stove populations had to be estimated for 1998 (the last year allowing new woodburning fireplaces or new non-Phase II wood stoves). The number of housing units in the CO Nonattainment Area for 1994 was determined by multiplying the fraction of Maricopa County population in the CO Nonattainment Area (0.987) by the number of housing units in Maricopa County (973,136) for 1994. This calculation yielded 960,485 households in 1994. The population growth factors, which are the growth factors used to project housing growth, were updated as a result of the 1995 Special Census and are as follows:

Base Year	Projection Year	Population Growth Factor
1994	1998	1.1936
1994	2006	1.4442
1994	2015	1.7411

The MAG residential wood combustion survey showed that 398 out of the 1416 respondents had a fireplace and 16 out of 1416 respondents had a wood stove. Therefore, to obtain the population of fireplaces or wood stoves in the CO Nonattainment Area for a given year, the 1994 number of residences was multiplied by the population growth factor for that year and the fraction of respondents who had either a fireplace or a wood stove.

The projected populations were then split into non-Phase II and Phase II fireplaces/wood stoves. All fireplaces and stoves built in 1998 or earlier are considered to be non-Phase II, while those built after 1998 are assumed to be Phase II or equivalent only. As described below, it is assumed that the Phase II fireplaces and the Phase II wood stoves are 51 percent and 23 percent cleaner, respectively, than their non-Phase II counterparts.

AP-42 emission factors were used to calculate the impact of the measure. In the case of wood stoves, the emissions from conventional wood stoves (115.4 g CO/kg wood), noncatalytic wood stoves (70.4 g CO/kg wood), and catalytic wood stoves (52.2 g CO/kg wood) were assumed to have equal weighting in the overall emissions of non-Phase II wood stoves. As a result, the overall non-Phase II wood stove emission factor is 79.3 g CO/kg wood. Similarly, the noncatalytic Phase II wood stoves (70.4 g CO/kg wood) and the catalytic Phase II wood stoves (52.2 g CO/kg wood) were assumed to have equal weighting in the overall emissions of Phase II wood stoves. Therefore, the overall Phase II wood stove emission factor is 61.3 g CO/kg wood. The ratio of the Phase II wood stove emission factor to the non-Phase II wood stove overall emission factor is 61.3/79.3 or 0.77. In the case of fireplaces, the Phase II emission factor was considered to be the same as the wood stove Phase II emission factor (61.3 g CO/kg wood). The emission factor for non-Phase II fireplaces is 126.3 g CO/kg wood and the ratio of the Phase II fireplace emissions to the non-Phase II fireplace emissions is 61.3/126.3 or 0.485. All emission factors were obtained from the EPA document, Compilation of Air Pollutant Emission Factors (January, 1995). In the case of noncatalytic wood stoves, non-Phase II and Phase II emissions were the same because the emission factor in the "all" category, used for the non-Phase II emissions, was the same as the Phase II emission factor and no other information was available.

To estimate the control factors for fireplace and wood stove CO emissions for 2006 and 2015, the total number of fireplaces or wood stoves, the number of new fireplaces or stoves, and the effective number of fireplaces or stoves was determined. The total number of fireplaces (or wood stoves) is the total population calculated as described above. The number of Phase II or equivalent fireplaces (or wood stoves) in 2006 and 2015 is the total population in that year minus the 1998 population. In all cases, the non-Phase II population was assumed to be the 1998 population. The effective population of fireplaces and wood stoves was determined from Equation One. Equation Two was used to determine the fraction of emissions remaining as a result of the measure.

(1) effective pop. = non-Phase II pop. + [Phase II pop. * (Phase II emission rate/ non-Phase II emission rate)]

(2) fraction of emissions remaining = effective population / total population

Wood Burning Fireplace Control Factor Calculations

	1998	2006	2015
Total Fireplace Population*	322,245	389,876	470,030
Non-Phase II Fireplace Population	322,245	322,245	322,245
Phase II Fireplace Population	0	67,631	147,785
Effective Fireplace Population	322,245	355,384	394,660
Control Factor	1.000	0.912	0.840

* Fireplace population in CO nonattainment area.

Wood Burning Stove Control Factor Calculations

	1998	2006	2015
Total Wood Stove Population*	12,955	15,673	18,896
Non-Phase II Wood Stove Population	12,955	12,955	12,955
Phase II Wood Stove Population	0	2,719	5,941
Effective Wood Stove Population	12,955	15,075	17,589
Control Factor	1.000	0.962	0.931

* Woodstove population in CO nonattainment area.

A /PROJECT AMS/ packet applied a factor of 0.912 to fireplaces (ASC 2104008001) and 0.962 to wood stoves (ASC 2104008010) for 2006. A /PROJECT AMS/ packet applied a factor of 0.840 to fireplaces (ASC 2104008001) and 0.931 to wood stoves (ASC 2104008010) for 2015. The newly created packet was applied by an additional execution of the CNTLEM module after the base case projections and controls were applied.

COMMITTED MAINTENANCE MEASURE #9

Off Road Vehicle and Engine Standards

March 26, 2003

The impact of the new off road engine standards was estimated by comparing the new Federal Phase II emission standards (40 CFR Parts 89 and 90) to the emission rates used to create the emission inventory. The emission rates used to create the inventory were obtained from the Nonroad Engine and Vehicle Emission Study, EPA 21A-2001, November 1991. The emission rate ratio represents the fraction of CO that an engine built to meet the new standards will emit compared to the CO emissions of an engine built to meet the existing standards (see Equation One).

$$Emission\ Rate\ Ratio = \frac{Federal\ Phase\ II\ Standard}{NEVES\ Emission\ Factor} \quad ...(1)$$

In cases where the new standard was greater than the existing emission rate, the emission rate ratio was set to one.

Depending on the nonroad engine classification, new emission standards were implemented in 1999 or will be implemented between the years 2000 and 2004. The number of model years affected by the new standards was calculated by subtracting the year in which the standard was implemented from 2006 and 2015 (see Equations Two and Three).

$$Model\ Years\ Affected = 2015 - Year\ of\ Implementation \quad ...(3)$$

It was assumed that spark-ignition engines have a useful life of seven years and that 14 percent of the engines are replaced each year. Since 2015 is more than seven years beyond the implementation of the new standards, it is assumed that by 2015 all of the nonroad spark-ignition engines will meet the new standards. It was assumed that compression ignition engines have a useful life of twenty-five years and that four percent of the engines are replaced per year. Due to the long useful life of compression ignition engines, only a fraction of the compression ignition engines will be replaced with engines meeting the new standard by 2015.

The number of model years affected by the new standards was multiplied by the fraction of nonroad engines that are assumed to be replaced each year. The product of these two factors is the fraction of the nonroad engine class that has been replaced by engines meeting the new standard in 2006 and 2015 (see Equation Four).

$$Fraction\ Replaced = (Model\ Years\ Affected) \times (Fraction\ Replaced\ Per\ Year) \quad ...(4)$$

Equation Five displays the methodology used to calculate the control factors. The control factors and the data used to calculate the control factors are presented in Attachment One. The control factors were applied through EPS2.0 by an additional application of the CNTLM module after the nonroad inventory was projected to 2006 and 2015.

$$Control\ Factor = (Emission\ Rate\ Ratio\ x\ Fraction\ Replaced) + (1 - Fraction\ Replaced) ...(5)$$

The nonroad engine standards apply to spark-ignition equipment rated less than 25 horsepower. The EPA memorandum entitled Future Nonroad Emission Reduction Credits for Court-Ordered Nonroad Standards was used to determine which categories of nonroad spark ignition equipment are considered to be composed of engines rated less than 25 horsepower. The nonroad engine standards for spark-ignition engines are based on five classes of engine: Class I includes nonhandheld engines with displacement less than 225 cc; Class II includes nonhandheld engines with displacements greater than or equal to 225 cc; Class III includes handheld engines with displacements less than 20 cc; Class IV includes handheld engines with displacements greater than or equal to 20 cc and less than 50 cc; and Class V includes handheld engines with displacements greater than or equal to 50 cc. Spark-ignition engines in the NEVES inventory were categorized by equipment type (e.g. lawnmowers and edgers). Therefore, it was necessary to make assumptions concerning which spark-ignition equipment types in the NEVES inventory were handheld and which were nonhandheld. Handheld equipment is defined as equipment that can be picked up and used by hand, whereas nonhandheld equipment is defined as equipment that must remain on the ground to be used. It was assumed that lawn and garden equipment with the following ASC codes were handheld: 2260004020, 2265004020, 2260004025, 2265004025, 2260004030, and 2265004030. All other spark-ignition nonroad equipment affected by the new standards were considered to be nonhandheld equipment.

In the new federal standards, handheld spark-ignition equipment is divided into three classes based on engine displacement. Since no data are available to divide the handheld spark-ignition equipment in the inventory by engine displacement, it was assumed that all handheld spark-ignition equipment would meet the class IV and class V standards. These standards are less stringent than the class III standard. In the new standards, nonhandheld spark-ignition equipment is broken down into two classes. However, the standards are equivalent for the two classes. Therefore, it was unnecessary to subdivide the nonhandheld spark-ignition equipment in the inventory.

New nonroad engine standards for compression ignition engines are based on horsepower ranges. There are nine horsepower (hp) ranges for compression ignition engines: < 11 hp, 11 - 25 hp, 25 - 50 hp, 50 - 100 hp, 100 - 175 hp, 175 - 300 hp, 300 - 600 hp, 600 - 750 hp, and > 750 hp. The average horsepower listed in the NEVES inventory for each compression ignition equipment type was used to determine the applicable new standard.

Attachment One

Table 1. Spark-ignition Engines (gasoline) 2006 and 2015 Control Factors

Equipment Type	ASC Code	NEVES Emission Factor (g/bhp-hr)	Federal Engine Classification	Federal Emission Standard (g/bhp-hr)	Start Year	2006 Control Factor	2015 Control Factor
2-Stroke Gasoline							
Trimmers/Edgers/Brush Cutters	2260004025	1383.62	Handheld	600	2004	0.8414	0.4336
Lawn Mowers	2260004010	923.4	Nonhandheld	455	2003	0.7870	0.4927
Leaf Blowers/Vacuums	2260004030	1361.94	Handheld	600	2004	0.8434	0.4405
Rear Engine Riding Mowers	2260004040	Not in Inventory					
Front Mowers	2260004045	Not in Inventory					
Chainsaws <4 HP	2260004020	1328.1	Handheld	600	2004	0.8465	0.4518
Shredders <5 HP	2260004050	923.4	Nonhandheld	455	2003	0.7870	0.4927
Tillers <5 HP	2260004015	923.4	Nonhandheld	455	2003	0.7870	0.4927
Lawn & Garden Tractors	2260004055	Not in Inventory					
Wood Splitters	2260004060	Not in Inventory					
Commercial Turf Equipment	2260004070	923.4	Nonhandheld	455	2003	0.7870	0.4927
Other Lawn & Garden Equipment	2260004075	923.4	Nonhandheld	455	2003	0.7870	0.4927
Golf Carts	2260001050	1520	Nonhandheld	455	2003	0.7057	0.2993
Specialty Vehicle Carts	2260001060	1520	Nonhandheld	455		0.7057	0.2993
Generator Sets <50 HP	2260006005	923.4	Nonhandheld	455	2003	0.7870	0.4927
Pumps <50 HP	2260006010	214.7	Nonhandheld	455	2003	1.0000	1.0000
Air Compressors <50 HP	2260006015	Not in Inventory					
Welders <50 HP	2260006025	Not in Inventory					
Pressure Washers <50 HP	2260006030	Not in Inventory					
Other General Industrial Equipment	2260003040	631.8	Nonhandheld	455	2003	0.8825	0.7202
Tampers/Rammers	2260002006	923.4	Nonhandheld	455	2003	0.7870	0.4927
Plate Compactors	2260002009	923.4	Nonhandheld	455	2003	0.7870	0.4927
Paving Equipment	2260002021	923.4	Nonhandheld	455	2003	0.7870	0.4927
Surfacing Equipment	2260002024	Not in Inventory					
Signal Boards	2260002027	Not in Inventory					
Concrete/Industrial Saws	2260002039	Not in Inventory					
Cement and Mortar Mixers	2260002042	Not in Inventory					
Dumpers/Tenders	2260002078	Not in Inventory					
2-Wheel Tractors	2260005010	Not in Inventory					
Agricultural Mowers	2260005030	Not in Inventory					
Tillers > 5 HP	2260005040	Not in Inventory					
Hydro Power Units	2260005050	Not in Inventory					
Chain Saws	2260007005	974.7	Nonhandheld	455	2003	0.8385	0.4668
Shredders	2260007010	Not in Inventory					
4-Stroke Gasoline							
Trimmers/Edgers/Brush Cutters	2265004025	747.35	Handheld	600	2004	0.9448	0.8028
Lawn Mowers	2265004010	817	Nonhandheld	455	2003	0.8139	0.5569
Leaf Blowers/Vacuums	2265004030	722.57	Handheld	600	2004	0.9525	0.8304

Table 1. (Continued) Spark-ignition Engines (gasoline) 2006 and 2015 Control Factors

Equipment Type	ASC Code	NEVES Emission Factor (g/bhp-hr)	Federal Engine Classification	Federal Emission Standard (g/bhp-hr)	Start Year	2006 Control Factor	2015 Control Factor
Rear Engine Riding Mowers	2265004040	670.7	Nonhandheld	455	2003	0.8649	0.6784
Front Mowers	2265004045	670.7	Nonhandheld	455	2003	0.8649	0.6784
Chainsaws <4 HP	2265004020	Not in Inventory					
Shredders <5 HP	2265004050	817	Nonhandheld	455	2003	0.8139	0.5569
Tillers <5 HP	2265004015	817	Nonhandheld	455	2003	0.8139	0.5569
Lawn & Garden Tractors	2265004055	672.6	Nonhandheld	455	2003	0.8641	0.6765
Wood Splitters	2265004060	817	Nonhandheld	455	2003	0.8139	0.5569
Commercial Turf Equipment	2265004070	672.6	Nonhandheld	455	2003	0.8641	0.6765
Other Lawn & Garden Equipment	2265004075	817	Nonhandheld	455	2003	0.8139	0.5569
Golf Carts	2265001050	1852.5	Nonhandheld	455	2003	0.6832	0.2456
Specialty Vehicles Carts	2265001060	1852.5	Nonhandheld	455	2003	0.6832	0.2456
Generator Sets <50 HP	2265006005	670.7	Nonhandheld	455	2003	0.8649	0.6784
Pumps <50 HP	2265006010	670.7	Nonhandheld	455	2003	0.8649	0.6784
Air Compressors <50 HP	2265006015	670.7	Nonhandheld	455	2003	0.8649	0.6784
Welders <50 HP	2265006025	670.7	Nonhandheld	455	2003	0.8649	0.6784
Pressure Washers < 50 HP	2265006030	670.7	Nonhandheld	455	2003	0.8649	0.6784
Other General Industrial Equipment	2265003040	258.7	Nonhandheld	455	2003	1.0000	1.0000
Tampers/Rammers	2265002006	376.2	Nonhandheld	455	2003	1.0000	1.0000
Plate Compactors	2265002009	376.2	Nonhandheld	455	2003	1.0000	1.0000
Rollers	2265002015	383.8	Nonhandheld	455	2003	1.0000	1.0000
Paving Equipment	2265002021	376.2	Nonhandheld	455	2003	1.0000	1.0000
Surfacing Equipment	2265002024	376.2	Nonhandheld	455	2003	1.0000	1.0000
Signal Boards	2265002027	376.2	Nonhandheld	455	2003	1.0000	1.0000
Concrete/Industrial Saws	2265002039	376.2	Nonhandheld	455	2003	1.0000	1.0000
Cement and Mortar Mixers	2265002042	376.2	Nonhandheld	455	2003	1.0000	1.0000
Dumpers/Tenders	2265002078	376.2	Nonhandheld	455	2003	1.0000	1.0000
2-Wheel Tractors	2265005010	271.7	Nonhandheld	455	2003	1.0000	1.0000
Agricultural Mowers	2265005030	414.2	Nonhandheld	455	2003	1.0000	1.0000
Sprayers	2265005035	283.4	Nonhandheld	455	2003	1.0000	1.0000
Tillers	2265005040	817	Nonhandheld	455	2003	0.8139	0.5569
Hydro Power Units	2265005050	414	Nonhandheld	455	2003	1.0000	1.0000
Chain Saws	2265007005	Not in Inventory					
Shredders	2265007010	Not in Inventory					

Table 2. Compression Ignition Engines (diesel) 2006 and 2015 Control Factors

Equipment Type	ASC Code	NEVES Emission Factor (g/bhp-hr)	Assumed Horsepower Range	Federal Emission Standard (g/bhp-hr)	Start Year	2006 Control Factor	2015 Control Factor
Trimmers/Edgers/Brush Cutters	2270004025	Not in Inventory					
Lawn Mowers	2270004010	Not in Inventory					
Leaf Blowers/Vacuums	2270004030	Not in Inventory					
Rear Engine Riding Mowers	2270004040	5	11 to 25	4.9	2000	0.9952	0.9880
Front Mowers	2270004045	Not in Inventory					
Chainsaws <4 HP	2270004020	Not in Inventory					
Shredders <5 HP	2270004050	Not in Inventory					
Tillers <5 HP	2270004015	Not in Inventory					
Lawn & Garden Tractors	2270004055	5	11 to 25	4.9	2000	0.9952	0.9880
Wood Splitters	2270004060	5	50 to 100	3.7	2004	0.9792	0.8856
Chippers/Stump Grinders	2270004065	5	50 to 100	3.7	2004	0.9792	0.8856
Commercial Turf Equipment	2270004070	Not in Inventory					
Other Lawn & Garden Equipment	2270004075	5	11 to 25	4.9	2000	0.9952	0.9880
Aircraft Support Equipment	2270008005	6.06	100 to 175	3.7	2003	0.9533	0.8131
Terminal Tractors	2270008010	6.06	50 to 100	3.7	2004	0.9688	0.8286
All Terrain Vehicles (ATVs)	2270001030	Not in Inventory					
Minibikes	2270001040	Not in Inventory					
Off-Road Motorcycles	2270001010	Not in Inventory					
Golf Carts	2270001050	Not in Inventory					
Specialty Vehicles Carts	2270001060	Not in Inventory					
Generator Sets <50 HP	2270006005	5	11 to 25	4.9	2000	0.9952	0.9880
Pumps <50 HP	2270006010	5	11 to 25	4.9	2000	0.9952	0.9880
Air Compressors <50 HP	2270006015	5	25 to 50	4.1	1999	0.9496	0.8848
Gas Compressors <50 HP	2270006020	Not in Inventory					
Welders <50 HP	2270006025	5	25 to 50	4.1	1999	0.9496	0.8848
Pressure Washers <50 HP	2270006030	5	11 to 25	4.9	2000	0.9952	0.9880
Aerial Lifts	2270003010	6.06	25 to 50	4.1	1999	0.9094	0.7930
Forklifts	2270003020	6.06	50 to 100	3.7	2004	0.9688	0.8286
Sweepers/Scrubbers	2270003030	6.06	50 to 100	3.7	2004	0.9688	0.8286
Other General Industrial Equipment	2270003040	6.06	100 to 175	3.7	2003	0.9533	0.8131
Other Material Handling Equipment	2270003050	6.06	100 to 175	3.7	2003	0.9533	0.8131
Asphalt Pavers	2270002003	3.2	50 to 100	3.7	2004	1.0000	1.0000
Tampers/Rammers	2270002006	Not in Inventory					
Plate Compactors	2270002009	3.1	0 to 11	6	2000	1.0000	1.0000
Concrete Pavers	2270002012	4.57	100 to 175	3.7	2003	0.9772	0.9086
Rollers	2270002015	3.1	50 to 100	3.7	2004	1.0000	1.0000
Scrapers	2270002018	5	300 to 600	2.6	2001	0.9040	0.7312
Paving Equipment	2270002021	4.6	50 to 100	3.7	2004	0.9843	0.9139
Surfacing Equipment	2270002024	Not in Inventory					
Signal Boards	2270002027	5	0 to 11	6	2000	1.0000	1.0000

Table 2. (Continued) Compression Ignition Engines (diesel) 2006 and 2015 Control Factors

Equipment Type	ASC Code	NEVES Emission Factor (g/bhp-hr)	Assumed Horsepower Range	Federal Emission Standard (g/bhp-hr)	Start Year	2006 Control Factor	2015 Control Factor
Trenchers	2270002030	9.14	50 to 100	3.7	2004	0.9524	0.7381
Bore/Drill Rigs	2270002033	9.2	175 to 300	2.6	2003	0.9522	0.6557
Excavators	2270002036	5.2	175 to 300	2.6	2003	0.9400	0.7600
Concrete/Industrial Saws	2270002039	9.2	50 to 100	3.7	2004	0.9522	0.7370
Cement and Mortar Mixers	2270002042	4.6	0 to 11	6	2000	1.0000	1.0000
Cranes	2270002045	4.2	175 to 300	2.6	2003	0.9543	0.8171
Graders	2270002048	3.8	100 to 175	3.7	2003	0.9968	0.9874
Off-Highway Trucks	2270002051	2.8	300 to 600	2.6	2001	0.9857	0.9600
Crushing/Proc. Equipment	2270002054	9.2	100 to 175	3.7	2003	0.9283	0.7130
Rough Terrain Forklifts	2270002057	10	50 to 100	3.7	2004	0.9496	0.7228
Rubber Tired Loaders	2270002060	4.8	100 to 175	3.7	2003	0.9725	0.8900
Rubber Tired Dozers	2270002063	2.8	300 to 600	2.6	2001	0.9857	0.9600
Tractors/Loaders/Backhoes	2270002066	6.8	50 to 100	3.7	2004	0.9635	0.7994
Crawler Tractors	2270002069	4.8	100 to 175	3.7	2003	0.9725	0.8900
Skid Steer Loaders	2270002072	9	25 to 50	4.1	1999	0.8476	0.6516
Off-Highway Tractors	2270002075	14.68	175 to 300	2.6	2003	0.9013	0.6050
Dumpers/Tenders	2270002078	2.8	11 to 25	4.9	2000	1.0000	1.0000
Other Construction Equipment	2270002081	9.2	100 to 175	3.7	2003	0.9283	0.7130
2-Wheel Tractors	2270005010	Not in Inventory					
Agricultural Tractors	2270005015	8.94	50 to 100	3.7	2004	0.9531	0.7421
Agricultural Mowers	2270005030	Not in Inventory					
Combines	2270005020	4.2	100 to 175	3.7	2003	0.9857	0.9429
Sprayers	2270005035	3.78	50 to 100	3.7	2004	0.9983	0.9907
Balers	2270005025	3.78	50 to 100	3.7	2004	0.9983	0.9907
Tillers >5 HP	2270005040	5	0 to 11	6	2000	0.9496	1.0000
Swathers	2270005045	2.1	50 to 100	3.7	2004	1.0000	1.0000
Hydro Power Units	2270005050	3.78	25 to 50	4.1	1999	1.0000	1.0000
Other Agricultural Equipment	2270005055	4.37	50 to 100	3.7	2004	0.9877	0.9325
Chainsaws >4 HP	2270007005	Not in Inventory					
Shredders >5 HP	2270007010	Not in Inventory					
Skidders	2270007015	Not in Inventory					
Fellers/Bunchers	2270007020	Not in Inventory					

APPENDIX B

APPENDIX B

EXHIBIT 1

Public Hearing Process Documentation

CERTIFICATION OF HOLDING OF PUBLIC HEARING ON THE MAG CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

I affirm that a public hearing was held by the Maricopa Association of Governments (MAG) starting at 5:30 p.m. Monday, May 5, 2003 at the MAG Offices, Saguaro Room, 302 North 1st Avenue, Phoenix, Arizona and that the hearing was held in accordance with the Arizona open meeting laws and 40 CFR 51.102 (d) to receive public comment on the MAG Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area.

5/5/03
Date

Pat Cupell
Pat Cupell, Arizona Department of Transportation
Member of the MAG Air Quality Technical
Advisory Committee/Hearing Officer

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

Personally appeared before me the above-named Pat Cupell known to me to be the same person who executed the foregoing instrument and to be the Arizona Department of Transportation representative on the Maricopa Association of Governments Air Quality Technical Advisory Committee and acknowledged to me that he executed the same as his free act.

SUBSCRIBED AND SWORN TO before me on this 6th day of May 2003.

Valerie Day
Notary Public

OFFICIAL SEAL
VALERIE DAY
NOTARY PUBLIC-ARIZONA
MARICOPA COUNTY
My Comm. Expires Aug. 16, 2004

My Commission Expires:

August 16, 2004

PUBLIC HEARING ON THE CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

May 5, 2003 at 5:30 p.m. MAG Offices, Saguaro Room 302 N. 1st Avenue, Second Floor Phoenix, Arizona 85003

The Maricopa Association of Governments (MAG) will conduct a public hearing on the Draft Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. The purpose of the hearing is to receive public comments.

MAG is requesting that the U.S. Environmental Protection Agency redesignate the Maricopa County nonattainment area to attainment for carbon monoxide. No violations of the federal carbon monoxide standards have occurred in the area since 1996. The modeling analysis in the maintenance plan demonstrates that the standards will continue to be met through 2015. With the submittal of this request and plan, the Maricopa County nonattainment area has satisfied all of the requirements to be redesignated to attainment for carbon monoxide.

The draft document is available for review at the MAG Offices, third floor, from 8:30 a.m. to 5:30 p.m. Public comments are welcome at the hearing, or may be submitted in writing by 5:30 p.m. on May 5, 2003 to Lindy Bauer at the address below. After considering the public comments, the MAG Regional Council may take action on the redesignation request and maintenance plan on May 28, 2003.

Contact person: Lindy Bauer, MAG (602) 254-6300
302 N. 1st Avenue, Suite 300
Phoenix, AZ 85003
03176-April 3, 2003.

AFFIDAVIT OF PUBLICATION

THE ARIZONA REPUBLIC

STATE OF ARIZONA
COUNTY OF MARICOPA } SS.

TOM BIANCO, being first duly sworn, upon oath deposes and says: That he is the legal advertising manager of the Arizona Business Gazette, a newspaper of general circulation in the county of Maricopa, State of Arizona, published at Phoenix, Arizona, by Phoenix Newspapers Inc., which also publishes The Arizona Republic, and that the copy hereto attached is a true copy of the advertisement published in the said paper on the dates as indicated.

The Arizona Republic

4/3/2003

Sworn to before me this
4TH day of
April A.D. 2003

OFFICIAL SEAL
GLORIA SALDIVAR
NOTARY PUBLIC-ARIZONA
MARICOPA COUNTY
My Comm. Expires Dec. 1, 2003

Gloria Saldivar

Notary Public

MARICOPA
ASSOCIATION of
GOVERNMENTS

302 North 1st Avenue, Suite 300 ▲ Phoenix, Arizona 85003
Phone (602) 254-6300 ▲ FAX (602) 254-6490
Email: mag@mag.maricopa.gov ▲ Website: www.mag.maricopa.gov

April 3, 2003

TO: Interested Parties for Air Quality

FROM: Lindy Bauer, Environmental Manager

SUBJECT: PUBLIC HEARING ON THE CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

Public Hearing
May 5, 2003 at 5:30 p.m.
MAG Office, Saguaro Room
302 N. 1st Avenue, Second Floor
Phoenix, Arizona 85003

The Maricopa Association of Governments (MAG) will conduct a public hearing on the Draft Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. The purpose of the hearing is to receive public comments on the redesignation request and maintenance plan which demonstrates that the carbon monoxide standards will continue to be met through 2015.

The U.S. Environmental Protection Agency is also being requested to redesignate the nonattainment area to attainment for carbon monoxide. There have been no violations of the federal carbon monoxide standards in the area since 1996. For your information and convenience, a copy of the public hearing notice is enclosed. The documents are available for public review at the MAG Office, third floor, from 8:30 a.m. Monday through Friday.

Please publish the following announcement as a legal advertisement in the Arizona Republic on Thursday, April 3, 2003.

PUBLIC HEARING ON THE CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

May 5, 2003 at 5:30 p.m.
MAG Offices, Saguaro Room
302 N. 1st Avenue, Second Floor
Phoenix, Arizona 85003

The Maricopa Association of Governments (MAG) will conduct a public hearing on the Draft Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. The purpose of the hearing is to receive public comments.

MAG is requesting that the U.S. Environmental Protection Agency redesignate the Maricopa County nonattainment area to attainment for carbon monoxide. No violations of the federal carbon monoxide standards have occurred in the area since 1996. The modeling analysis in the maintenance plan demonstrates that the standards will continue to be met through 2015. With the submittal of this request and plan, the Maricopa County nonattainment area has satisfied all of the requirements to be redesignated to attainment for carbon monoxide.

The draft document is available for review at the MAG Offices, third floor, from 8:30 a.m. to 5:30 p.m. Public comments are welcome at the hearing, or may be submitted in writing by 5:30 p.m. on May 5, 2003 to Lindy Bauer at the address below. After considering the public comments, the MAG Regional Council may take action on the redesignation request and maintenance plan on May 28, 2003.

Contact person: Lindy Bauer, MAG (602) 254-6300
302 N. 1st Avenue, Suite 300
Phoenix, AZ 85003

MARICOPA ASSOCIATION of GOVERNMENTS

302 North 1st Avenue, Suite 300 ▲ Phoenix, Arizona 85003
Phone (602) 254-6300 ▲ FAX (602) 254-6490
Email: mag@mag.maricopa.gov ▲ Website: www.mag.maricopa.gov

April 9, 2003

Arturo Espinoza
Chicanos Por La Causa
4622 W. Indian School Road, D12
Phoenix, Arizona 85031

Dear Mr. Espinoza:

You are cordially invited to the public hearing on the Draft Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. The hearing will be held on Monday, May 5, 2003 at 5:30 p.m. in the Saguaro Room at the MAG Office, 302 N 1st Avenue, Second Floor, Phoenix, Arizona, 85003. The purpose of the hearing is to discuss the draft document and receive comments. Written and verbal comments are welcomed at the public hearing. After considering the public comments, the MAG Regional Council may take action on the redesignation request and maintenance plan on May 28, 2003.

The U.S. Environmental Protection Agency is being requested to redesignate the Maricopa County nonattainment area to attainment for carbon monoxide. No violations of the federal carbon monoxide standards have occurred in the area since 1996. The air quality modeling analysis in the maintenance plan demonstrates that the standards will continue to be met through 2015. With the submittal of this request and plan, the Maricopa County nonattainment area has satisfied all of the requirements to be redesignated to attainment for carbon monoxide.

The draft documents are available for review at the MAG Office, third floor, from 8:30 a.m. to 5:30 p.m., Monday through Friday. We hope to see you or your representative at the hearing and to include your input in future planning efforts. If you have any questions or would like to set up a time for us to meet with your organization, please call me at (602) 254-6300.

Sincerely,

Lindy Bauer

Lindy Bauer
Environmental Manager

MARICOPA
ASSOCIATION of
GOVERNMENTS

302 North 1st Avenue, Suite 300 ▲ Phoenix, Arizona 85003
Phone (602) 254-6300 ▲ FAX (602) 254-6490
Email: mag@mag.maricopa.gov ▲ Website: www.mag.maricopa.gov

April 10, 2003

TO: Leslie Rogers, Federal Transit Administration
Robert Hollis, Federal Highway Administration
Stephen Owens, Arizona Department of Environmental Quality
Victor Mendez, Arizona Department of Transportation
Ken Driggs, Regional Public Transportation Authority
Al Brown, Maricopa County Environmental Services Department
Colleen McKaughan, U. S. Environmental Protection Agency, Region IX

FROM: Lindy Bauer, Environmental Manager

SUBJECT: TRANSMITTAL OF THE DRAFT CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

The Maricopa Association of Governments has prepared a Draft Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area (see attachment). The U.S. Environmental Protection Agency is being requested to redesignate the Maricopa County nonattainment area to attainment for carbon monoxide. No violations of the federal carbon monoxide standards have occurred in the area since 1996.

The air quality modeling analysis in the maintenance plan demonstrates that the standards will continue to be met through 2015. With the submittal of this request and plan, the Maricopa County nonattainment area has satisfied all of the requirements to be redesignated to attainment for carbon monoxide.

On May 5, 2003, a public hearing will be conducted at the MAG Offices, Saguaro Room, Second Floor, Phoenix, Arizona at 5:30 p.m. After considering public comments, the MAG Regional Council may take action on the redesignation request and maintenance plan on May 28, 2003. If you have any questions, please do not hesitate to contact me at (602) 254-6300.

CARBON MONOXIDE REDESIGNATION REQUEST
AND MAINTENANCE PLAN FOR
THE MARICOPA COUNTY NONATTAINMENT AREA

PUBLIC HEARING

Phoenix, Arizona
May 5, 2003

DESERT HILLS REPORTING, INC.
235 W. Ridgecrest Road
Phoenix, Arizona 85086
By: Terese M. Heisig/RPR
Certified Court Reporter 50378

APPEARANCES:

Maricopa Association of Governments
By: Ms. Lindy Bauer

Arizona Department of Transporation
By: Mr. Pat Cupell

16:34:28

Citizens Present:

Ms. Carolyn Novak
Mr. Roger Roy
Ms. Cathy Arthur
Ms. Dianne Barker

17:18:07 MR. CUPELL: I would like to go ahead and call
17:18:09 this public hearing to order and welcome those in
17:18:12 attendance to the public hearing. The purpose of the
17:18:15 hearing is to receive public comments on the draft
17:18:18 M.A.G. carbon monoxide redesignation request and
17:18:21 maintenance plan for the Maricopa County nonattainment
17:18:24 area. For those driving to the meeting who parked in
17:18:27 the garage, you can have your tickets validated by the
17:18:30 M.A.G. staff.

17:18:31 The public hearing will begin with an overview
17:18:34 presentation by M.A.G. staff. Following the
17:18:37 presentation of the hearing, participants are invited to
17:18:40 make comments for the public record. The court reporter
17:18:42 is present to provide an official record of the hearing,
17:18:46 and written comments are, also, welcome.

17:18:48 For those participants wishing to speak, please
17:18:52 fill out a form on the table located right outside the
17:18:55 door and place it in the box. I would like to note that
17:18:58 we have a timer to assist the public with their
17:19:02 presentations. We have a three-minute time limit. When
17:19:06 two minutes have elapsed, the yellow light will come on,
17:19:09 notifying the speaker they have one minute to sum up.
17:19:12 At the end of the three-minute time limit, the red light
17:19:15 will come on.

17:19:17 Now, Lindy Bauer will make a presentation. Lindy

17:19:21 Bauer, the M.A.G. staff, will make a presentation on the M.A.G. carbon monoxide redesignation request and maintenance plan.

17:19:41 MS. BAUER: Thank you very much. I would like to welcome you to the public hearing this evening. The carbon monoxide pollution problem that we have in this region is a wintertime problem. We have this during the winter months. It is colorless and odorless, but it is one of the pollutants regulated by the Environmental Protection Agency. The standard for carbon monoxide to protect public health is nine parts per million for an eight-hour average.

17:20:12 Now, we have some good news to report to you this evening. As far as the number of exceedance days and violations of carbon monoxide over time, they are greatly diminished. This is a Serious carbon monoxide nonattainment area, and we are pleased to report to you that we have not had a violation of the carbon monoxide standard for six years, and we hope that this trend will continue into the future.

17:20:41 Since there have been no violations of the standards for six years, M.A.G. is now requesting redesignation to attainment status from the Environmental Protection Agency. If this effort is successful, then at the end of the effort, EPA will redesignate this region from a Serious nonattainment area to an attainment area for carbon monoxide.

There are a number of different steps in order to obtain a redesignation to attainment status from the Environmental Protection Agency. First of all, EPA has to determine that, indeed, the standard has been attained. Again, we've had six years with no violations. Secondly, EPA has to take action on the revised Serious Area Carbon Monoxide Plan. EPA has not yet taken official action to approve the plan. That plan was submitted, however, in March of 2001. Thirdly, the Environmental Protection Agency has to determine that the air quality improvement is due to permanent and enforceable reductions in emissions. These measures have to be sound and dependable to maintain good air quality over time and ensure that we meet the standard. Fourth, we have to demonstrate to the EPA that all applicable requirements under Section 110 and Part D of the Clean Air Act have been met.

Now, these sections of the Clean Air Act contain requirements for nonattainment areas. And lastly, the Environmental Protection Agency has to approve the maintenance plan. All of these steps have to be met in order for EPA to determine that we are no longer a Serious nonattainment area for carbon monoxide.

17:22:48 Now, the carbon monoxide maintenance plan that we have prepared and the redesignation request contain a 1990 periodic emmissions inventory. This was prepared by Maricopa County, and a portion was prepared by the Maricopa Association of Governments. The inventory indicates the sources of the various categories that contribute to carbon monoxide pollution. We, also, have to show that there is a program in place for the prevention of significant deterioration. This is under the authority of Maricopa County and the Arizona Department of Environmental Quality.

17:23:35 Conformity procedures have to be in place, and they are the Maricopa Association of Governments, and we have to produce emission budgets as part of this maintenance plan. The emission budgets are motor vehicle emission budgets that we use when we evaluate transportation plans to make sure that they are not going to contribute to air pollution problems. So budgets will be set for carbon monoxide in this maintenance plan.

17:24:09 We, also, have to have a contingency plan. The contingency plan is to contain some additional control measures that will give us extra benefits beyond what we need to maintain the carbon monoxide standard, and we have to have a process in place to prevent these problems from occurring in the first place.

And, finally, we have to track the maintenance plan itself to make sure that it works over time and prepare subsequent revisions that are required under the Clean Air Act. So M.A.G. and Maricopa County will be tracking the maintenance plan.

And, now, to show the measures that will be in this maintenance plan. The measures that we are using to provide to EPA as permanent and enforceable reductions in emissions are indicated on this table. At the top of the list, the measure with the biggest impact, is that wintertime clean burning gasoline. That is in place in the M.A.G. region and the Maricopa nonattainment area.

We, also, are receiving significant benefits from off-road vehicle and engine standards. Clean burning fireplace ordinances are very important and in effect throughout the Maricopa County nonattainment area. Coordinating traffic signal systems. And next we see some programs that are part of the vehicle inspection maintenance program run by the Arizona Department of Environmental Quality. The phased-in emission test cutpoints, tougher enforcement of vehicle registrations, the catalytic converter replacement program, the one-time waiver from the vehicle emissions test and, 17:26:14 also, developing intelligent transportation systems. These are the measures that we will rely on in order to maintain the carbon monoxide standard and make sure that we will not go over that standard.

We ran the air quality models all the way out to 2015 to make sure that the air would stay clean with these measures. The model indicates that we can still maintain the standard with these measures. The carbon monoxide measures that we will use for contingency are indicated on this table. First of all, there is a measure called the Area A expansion. This is the boundary drawn by the Arizona State Legislature, and within that boundary, the various areas are required to implement a wide variety of transportation control measures, for the most part.

So, again, this is a line drawn by the Arizona Legislature and defined by the Legislature. It is, actually, larger than the carbon monoxide nonattainment area. The Area A expansion is designed to make sure that as areas grow within Maricopa County, especially, that these areas will grow clean, because they will have to implement measures.

The second one is the gross emitter waiver provision. This is part of the State Vehicle Inspection Maintenance Program, and, also, the increased waiver repair limit. Now, for the carbon monoxide contingency plan, these measures are going to be implemented so they will give us extra benefits, and this is counted as early implementation of contingency measures as a way to try to prevent this region from ever going over the carbon monoxide standard again.

In addition, we, also, will have a process in place that if we have two verified readings exceeding nine parts per million at one monitor during a single carbon monoxide season, this will trigger a contingency process where we will then consider additional measures for possible implementation.

Now, for carbon monoxide for 2015, we wanted to show you what the emissions looked like, given that we will be able to maintain the standard in 2015. The concentration that our models are predicting for 2015 is 8.06 parts per million. Now, this concentration is below the standard of 9 parts per million. We, also, have an interim motor vehicle emmisions budget set in 2006. Now, this is not shown on this chart, but there is an interim motor vehicles emissions budget in the carbon monoxide maintenance plan. It is 699.7 metric tons per day. In addition, the budget for 2015 for motor vehicles is 662.9 tons metric tons per day.

So, again, those budgets will be the ones that we use for transportation conformity purposes under the Clean Air Act. But the major sources of emissions that you can see on this chart will be below EPA standard to protect public health of 9 parts per million. I, also, would like to mention that this afternoon we received some written comments from the Environmental Protection Agency and, also, the Western States Petroleum Association for entering into the public hearing record.

Thank you very much.

MR. CUPELL: Thank you, Lindy.

At this time, public comments will be invited. Again, if you would like to speak, please fill out a speaker form and place it in the box outside the door. We ask that you, please, adhere to the three-minute limit and, please, state your name when you come to the podium.

And first speaker's form I have here is from D.D. Barker.

MS. BARKER: Good afternoon. Thank you for this opportunity to speak, Mr. Chairman. My name is D.D. Barker, and I reside in Phoenix. I am a friend of transportation, and I have found that you can actually live in Phoenix without a car ownership. I try to bus, bike, and I do drive every now and then and carpool.

Why do I do this? Because I really do believe that Arizona, growing as it is, is the land as my mother said, the land that God brought us out here, and Ditat Deus, with God, our state motto means enriches. We need to have clean air, and we need to have clean water. Where I see we are going is if we don't watch out where we are going, we may end up there. EPA, as well as Lindy has stated, has five steps now to evaluate whether M.A.G. is going to be able to -- they've been able to maintain, according to Lindy, the CO, but, in the future, now, of the standards -- I submit to you, I'm an optimistic person, but I don't believe this will not work after studying this plan, I see that, Number 1, the maintenance for reformulated gas is going to be number one thing. First of all, that oxygenated fuel creates byproducts of aldehydes, which the EPA already knows are pollutants and carcinogens. The traffic signals, this trolly that we are putting $80 million a year discretionary funds of feds', they are going to be hard to get according to Eric Anderson, and, also, it will slow the traffic, particularly on Central Avenue, taking out a lane. The ITS, according to M.A.G. spokesman, about 15 percent it helps out. Vehicle registration, 41,000 vehicles since 1996. Those are the ones who were not registering. I imagine we have more, and we only

17:33:09 started to try to look into that. M.A.G. fireplace,
17:33:13 about 14,000 of them in about five years. May be 4,000
17:33:17 more folks with 3 million people going up to 5 million
17:33:22 in the next 10 years. This is a small amount,
17:33:26 fireplaces. Off-road standards for spark plug
17:33:30 engineering, that I don't have too much information on,
17:33:35 but I don't believe, as what Rich Banks, who is a
17:33:38 chemist -- he has been to M.A.G. before using a certain
17:33:41 modelling for the air quality, says it has its faults,
17:33:45 and EPA has a file, the federal standard, for this area
17:33:50 in the register. So let's watch out where we are going.
17:33:53 We may end up there.

17:33:54 I do believe until people will start seeing that
17:33:58 they either are part of the solution or part of the
17:34:01 problem and participate in our society for the future
17:34:06 better water and clean air that we will have this
17:34:09 ongoing problem. And thank you.

17:34:16 MR. CUPELL: Thank you. That was the only
17:34:31 speaker slip we had in the box, so, at this time, the
17:34:40 Maricopa Association of Governments appreciates your
17:34:43 interest in regional air quality, and your comments will
17:34:47 be presented to the M.A.G. Air Quality Technical
17:34:50 Advisory Committee on the May 8th, 2003, meeting. That
17:34:54 is at 1:30 p.m. And thank you for your participation
17:34:58 this evening.

17:35:01 (The public hearing concluded at 5:35 p.m.)

STATE OF ARIZONA.)
) SS.
COUNTY OF MARICOPA)

BE IT KNOWN that the foregoing public hearing was taken before me, Terese M. Heisig, Certified Court Reporter No. 50378 for the State of Arizona, in shorthand and thereafter transcribed under my direction, and that the foregoing pages of printed matter contain a full, true, and accurate transcript of all proceedings all to the best of my skill and ability.

DATED at Phoenix, Arizona, this 6th day of May, 2003.

Terese M Heisig

Terese M. Heisig, RPR
Certified Court Reporter 50378

PUBLIC HEARING SIGN IN SHEET

MAY, 5, 2003

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RESPONSE TO PUBLIC COMMENTS ON THE DRAFT MAG CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

MAY 5, 2003 PUBLIC HEARING

The Maricopa Association of Governments (MAG) appreciates the comments made during the public comment period for the Draft MAG Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. An advertised public hearing was conducted by MAG on May 5, 2003. One testimony was presented at the public hearing. In addition, written comments were submitted from two entities. The following represents the MAG response to the comments received.

COMMENTS FROM DIANNE BARKER (Testimony at the May 5, 2003 Public Hearing)

Comment: The maintenance for reformulated gas is going to be the number one thing. The oxygenated fuel creates byproducts of aldehydes, which the EPA already knows are pollutants and carcinogens.

Response: Wintertime CARB Phase 2 fuel with 3.5 percent oxygenate is the most effective measure for reducing carbon monoxide emissions in the CO Maintenance Plan. It reduces emissions by 21.5 percent when compared with fuels in 1994. Without this measure, the area can not show maintenance of the eight-hour standards through 2015. Study of toxics from sources such as gasolines is currently underway at the national level, but there are currently no health standards established by EPA for aldehydes.

Comment: The traffic signals, this trolley that we are putting $80 million a year discretionary funds of feds', they are going to be hard to get according to Eric Anderson, and, also, it will slow the traffic, particularly on Central Avenue, taking out a lane.

Response: The CO Maintenance Plan assumes that traffic signal system coordination will reduce CO emissions by about 0.2 percent in 2015. The light rail system, including the lane reduction on Central Avenue, was assumed in the 2015 traffic modeling performed for the CO maintenance plan.

Comment: The ITS according to MAG spokesman about 15 percent it helps out.

Response: The CO Maintenance Plan assumes that Intelligent Transportation Systems will reduce CO emissions by about 0.1 percent in 2015.

Comment: Vehicle registration, 41,000 vehicles since 1996. These are the ones who were not registering. I imagine we have more, and we only started to try to look into that.

Response: The purpose of the CO Maintenance Plan measure, Tougher Enforcement of Vehicle Registrations, is to reduce the number of vehicles that are not registering in Area A and as a result, are exempt from the Enhanced Vehicle Inspection Program. The Plan assumes that this measure will reduce CO emissions by about 0.2 percent in 2015.

Comment: MAG fireplaces, about 14,000 of them in about five years. Maybe 4,000 more folks with 3 million people going up to 5 million in the next 10 years. This is a small amount, fireplaces.

Response: The purpose of the CO Maintenance Plan measure, Clean Burning Fireplace Ordinances, is to ensure that new homes and businesses only have fireplaces that are EPA Phase II certified as clean burning. Although the Maintenance Plan assumes only a 0.3 percent reduction due to Clean Burning Fireplaces in 2015, this measure is an effective way to control increases in wood burning emissions due to population growth. Due to the measures in the CO Maintenance Plan, carbon monoxide concentrations will remain healthy through 2015 despite the major increases in population forecasted for the region.

Comment: Off-road standards for spark plug engineering, that I don't have too much information on, but I don't believe, as what Rich Banks, who is a chemist – he has been to MAG before using a certain modeling for the air quality, says it has its faults and EPA has a file, the federal standard, for this area in the register. So let's watch out where we are going. We may end up there.

Response: The CO Maintenance Plan measure, Off-Road Vehicle and Engine Standards, takes credit for EPA standards that are already being implemented on a national basis. The air quality modeling done by MAG for the CO Maintenance Plan uses models approved by EPA. The modeling also assumed the latest population, employment, and traffic forecasts available at the time.

Comment: I do believe until people will start seeing that they either are part of the solution or part of the problem and participate in our society for the future better water and clean air that we will have this ongoing problem.

Response: As indicated in Figure ES-1 of the CO Maintenance Plan, trends in carbon monoxide concentrations at the highest monitors in the Valley are continuing to decline. There have been no violations of the eight-hour carbon monoxide standard since 1996, despite a 25 percent increase in Maricopa County population. The CO Maintenance Plan indicates that the area will continue to attain the standard through 2015, ensuring that the 4.7 million people living in Maricopa County at that time, will continue to breathe air that has low levels of carbon monoxide.

COMMENTS FROM THE ENVIRONMENTAL PROTECTION AGENCY (E-mail dated May 5, 2003)

Comment: Thank you for the opportunity to review and comment on the draft MAG CO redesignation and maintenance plan. We are favorably impressed with MAG's efforts in streamlining the plan. We also want to thank you for your attention responding thoroughly to the comments on the previous draft, for your attention to correcting the conformity budget issues we raised on the previous draft, and for providing an electronic copy of the plan when you submit it to us. As you know, the electronic copy will facilitate our process of determining the adequacy of the budgets in the plan.

Response: MAG appreciates the thorough review and helpful comments provided by EPA on the preliminary and current drafts of the CO redesignation request and maintenance plan**.**

Comment: Our attorney Jeff Wehling felt the trigger for the contingency measures is not protective enough. Our understanding is that only two monitored CO concentrations of 9.5 or more at any one station in a calendar year would be considered a NAAQS violation, and thus, the proposed triggering scenario would not be sufficient to satisfy Section 175A(d) of the Act. The contingency measures portion of the plan should be modified to reflect this comment.

Response: The sentence on page 3-15 of the final document will be changed to: "Two verified readings exceeding 9.0 ppm *at one monitor* during a single carbon monoxide season (i.e. October 1 through March 31) will trigger consideration of additional measures, beyond the contingency measures shown in Figure 3-2 which have already been implemented." (Change shown in italics.) In a telephone conversation with Lindy Bauer and Cathy Arthur on March 5, 2003, Colleen McKaughan and Wienke Tax of EPA indicated that this change should satisfy Section 175A(d) of the Act. Colleen also indicated that she did not consider this to be a significant change to the Carbon Monoxide Maintenance Plan.

Comment: The Maintenance Plan states that 21.1 of 21.5 percent of the reduction from the oxygenated fuels program between 2000 and 2015 comes from low sulfur content. This leaves only 0.4 percent reductions in that period from RVP and oxygenate. Is the statement that 21.1% of the reductions come from low sulfur content correct? How was this number derived?

Response: The footnote in Figures ES-2 and 3-1 for the maintenance measure, CARB Phase 2 with 3.5 Percent Oxygenate in Winter, is correct. It should be noted that the reductions are based on a comparison of fuel programs in 1994 and 2015, rather than 2000 and 2015.

The 21.5 percent reduction in carbon monoxide emissions from wintertime CARB Phase 2 with 3.5 percent oxygenate reflects the effects of changes in sulfur content, oxygenate content, and reid vapor pressure (RVP) relative to the properties of gasoline in the 1994 base case. This reduction also incorporates the effects of the gasoline formulation changes on both onroad and nonroad engines. The effects of the changes in gasoline formulation on onroad engines were calculated using the EPA MOBILE6 model, while the effects of the changes in formulation on nonroad engines were calculated using the CO Complex Model.

MAG modeling shows that 98 percent of the 21.5 percent reduction in CO emissions (or 21.1 percent) is attributable to the low sulfur content of the CARB Phase 2 with 3.5 percent oxygenate fuel. The effects of oxygenate and RVP are relatively small for the reasons described below.

The properties of gasoline in 1994 are very close to full oxygenate content (83 percent market share to ethanol at 3.5 percent by volume and 17 percent market share to MTBE at 2.5 percent by volume), while the CARB Phase 2 with 3.5 percent oxygenate assumes a 100 percent market share to ethanol at 3.5 percent by volume. Additionally, the MOBILE6 model applies lesser credit to oxygenated gasoline than the MOBILE5 model did. The vapor pressures assumed for the base case and CARB Phase 2 with 3.5 percent oxygenate are relatively close, with a base case RVP of 8.5 psi and a CARB Phase 2 RVP of 9.0 psi.

The 21.1 percent of the modeled reduction was determined to be attributable to the lower fuel sulfur content by performing MOBILE6 runs where the sulfur content was set to the levels for CARB Phase 2 with 3.5 percent oxygenate (i.e. 30 ppm), while the oxygenate and RVP were set to their 1994 base case values. (For comparison, in the modeled base case fuel formulation, the sulfur content was 120 ppm). The reduction in CO emissions due to use of low sulfur fuels in nonroad engines is negligible, because lower sulfur improves catalytic converter performance and the CO Maintenance Plan assumes that nonroad engines do not have catalytic converters in 2015.

Comment: The measure "Defer emissions associated with government activities" is generally characterized as a measure for which no credit was taken. However, the response to comments states that "a 6% decrease in emissions was shifted." If we understand correctly that a decrease in one time period was balanced with an increase in another time period in the modeling, it would be clearer to say "6% of the emissions were shifted."

Response: To model the effects of this measure, six percent of the CO emissions from 2-stroke gasoline-powered engines were shifted from the post- 2 p.m. period to the pre-2 p.m. period. This will be noted in the second footnote on Figures ES-2 and 3-1, as well as the text on page 2-14, of the final document.

Comment: On the periodic inventories on page 2-23, it would be nice if you would list a start year and milestone years for the periodic inventories.

Response: Periodic inventories for carbon monoxide are prepared every three years by the Maricopa County Environmental Services Department with input from ADEQ, ADOT and MAG. The most recent 1999 periodic emissions inventory for carbon monoxide was submitted to EPA in August 2002 and is provided as Appendix A of the CO Maintenance Plan Technical Support Document. Work to prepare the 2002 inventory for carbon monoxide is underway. The text on page 2-23 will be modified in the final document to indicate that the 1999 periodic CO emissions inventory is included in Appendix A of the TSD and identify an expected completion date for the 2002 inventory.

COMMENTS FROM THE WESTERN STATES PETROLEUM ASSOCIATION (Letter dated May 5, 2003)

Comment: Redesignation Request First, WSPA would like to support MAG and the state in the Area A CO redesignation request to EPA. Similar to many other major population centers across the U.S., the air pollutant monitor data is clear that over the past several years the region has been able to attain the standard and sustain lower CO levels in the fact of tremendous growth in population and VMT.

Response: MAG appreciates WSPA's support in requesting that EPA redesignate the Serious carbon monoxide nonattainment area in Maricopa County to attainment. As shown in Figure ES-1 of the CO Maintenance Plan, the monitors have continued to show declines in average CO concentrations over time and no violations of the eight-hour standard have been recorded during the last six years, despite a 25% increase in Maricopa County population over the same period. As a point of clarification, the redesignation request applies to the carbon monoxide nonattainment area, an area in Maricopa County smaller than Area A.

Comment: Mobile 6 Problems Second, in terms of the CO Maintenance Plan, you have, over the past six months, been made aware of WSPA's concerns relative to the science being used in the Plan, and have reviewed the work that Sierra Research has completed for us. In the fall of 2002, Sierra Research raised concerns to Region 10 about the representativeness of projected carbon monoxide (CO) emission rates calculated by MOBILE6. Those concerns were related to assumptions about the effects of technology on CO rates in cold temperature climates and were based on analysis prepared for the Alaska Department of Environmental Conservation (ADEC).

During the same time period, additional CO-related assessments of other western nonattainment areas were being conducted by Sierra for WSPA. Based on these efforts, we have come to the conclusion that MOBILE6 forecasts of CO emission rates are seriously flawed. Moreover, we find that flaws in these forecasts are adversely impacting decisions about the need for control strategies in both cold-temperature and warm-weather CO nonattainment areas.

A number of studies published over the last year have raised concerns that MOBILE6 is over-predicting CO emissions from on-road motor vehicles. For example, a comparison of ambient CO trends versus MOBILE6 inventory trends conducted by Sierra has shown that ambient CO concentrations in many western communities dropped significantly between 1996 and 2001, while the trend in on-road motor vehicle CO emissions calculated with MOBILE6 is relatively flat during this time period. Environ Corporation compared CO emission rates based on tunnel studies to MOBILE6 predictions and found that the MOBILE6 results are "much higher" than the observed values for the Ft. McHenry, MD and Tuscarora Mountain, PA tunnel studies. Desert Research Institute compared remote sensing data collected in Clark County, Nevada, to MOBILE6 CO estimates and found that "the most important discrepancy" was for CO emissions from LDGVs, with MOBILE6 estimates being twice those of the on-road tests, suggesting "further examination of the model...is warranted." Finally, an evaluation of California's EMFAC2002 model prepared by Sierra has shown much lower light-duty vehicle CO emissions in absolute terms and a much steeper decline between 2000 and 2010 than predicted by MOBILE6.

No fewer than five separate communities in the west are considering revisions to their CO SIPs. Their choice of control measures is being restricted by conservative (i.e., inflated) CO emission rate projections incorporated into MOBILE6. As a result, communities are reluctant to eliminate existing control programs, even if they are no longer cost-effective. The communities currently considering SIP revisions include Anchorage, Fairbanks, Phoenix, Las Vegas and Spokane.

The large increase in projected CO rates combined with the large reductions predicted by MOBILE6 for wintertime RVP control ensures the continuance of these programs even when available data indicate that the benefits of these controls are marginal (this is the issue in Las Vegas and Phoenix). Similarly, the large increase in projected CO emission rates combined with rapidly declining but still substantial benefits of oxygenated fuels ensures the continuance of these programs (this is an issue in Spokane, Anchorage, Las Vegas, and Phoenix). Even more troubling is the fact that some communities are considering the adoption of additional controls to offset (a) the increase in projected CO rates and (b) conservative assumptions about the collateral benefits of technologies introduced to meet Tier 2 standards (this is an issue in Fairbanks and Spokane). Additional areas impacted by these concerns are those with existing maintenance plan control measure commitments and include Tucson, Reno, and Portland. Based on these findings, we are, and will continue, to urge EPA to prepare revisions to MOBILE6 CO emission rate projections and to develop and release a modified version of the model.

Presented below is a brief summary of model assumptions and inputs that should be considered for revision:

- Projected improvements in MOBILE6 CO rates are based on the ratio of future to current emission standards. Since many NLEV and Tier 2 vehicles have a CO certification standard equivalent to the Tier 1 CO standard of 3.4 g/mi, forecasts of CO emission rates do not account for concomitant reductions that will occur from the technology needed to meet the very stringent hydrocarbon standards required of NLEV and Tier 2 vehicles.

- The cold-temperature (i.e., below 75F) exhaust RVP correction factors used in MOBILE6 were developed for 1983 and newer model year vehicles and have not been revised since MOBILE4 was released in 1989. Since those exhaust RVP factors were developed, there have been significant changes in vehicle design that have dramatically reduced or eliminated the cause of RVP/exhaust interactions (i.e., much better fuel control and evaporative canister purge strategies leading to stoichiometric operation under nearly all operating conditions). Additional concerns include: (a) it appears that the analysis upon which the MOBILE4 factors are based failed to account for important differences in fuel properties such as sulfur content; (b) the exhaust RVP correction factors for temperatures below 75F are not based on actual emissions data but rather on extrapolations on the 75F estimates; and (c) RVP exhaust correction factors appear to be incorrectly applied to start emissions in MOBILE6.

- MOBILE6 assumptions about sulfur sensitivity appear to vary by certification category. As a result, CO rates from Tier 1 vehicles are projected by MOBILE6 to be lower than either NLEV or Tier 2- Bin 5 vehicles, assuming that Tier 2 sulfur requirements have been fully phased-in.

In summary, the issues outlined above raise legitimate concerns about the accuracy of projected CO emission rates in MOBILE6. While originally raised within the context of Alaska CO maintenance planning, the more recent Sierra Research work for WSPA shows that conservative assumptions about the collateral benefits of Tier 2 technology improvements are an issue for many western CO nonattainment and maintenance areas. That work also showed that problems with the benefits of wintertime RVP controls further complicate CO planning efforts.

WSPA believes a revised version of MOBILE6 reflecting the corrections discussed above would not jeopardize MAG's current efforts to demonstrate conformity or attainment of the CO NAAQS. We would like to have MAG's support, and ADEQ's for that matter, in advocating with the EPA that MOBILE6 needs to be fixed expeditiously. Alternatively, EPA needs to offer areas like Phoenix an approach to CO SIP development that does not rely strictly on rigorous application of MOBILE6 in its present form.

Response: The analysis presented by WSPA makes a strong case that carbon monoxide emission rates need to be re-evaluated and the MOBILE6 model updated as soon as possible, if EPA is in agreement. In the Federal Register releasing MOBILE6 on January 29, 2002, EPA states that "MOBILE6 should be used in SIP development as expeditiously as possible." This guidance also requires that MOBILE6 be used in conducting transportation conformity determinations after January 29, 2004.

To comply with this EPA guidance, MAG has used MOBILE6 to prepare the CO Maintenance Plan update to the SIP and establish 2006 interim and 2015 conformity budgets in the CO Maintenance Plan. MAG modeling with the current version of MOBILE6 has demonstrated maintenance of the eight-hour CO standard through 2015. If the mobile source emission rates in MOBILE6 are too high, as indicated by the WSPA analysis, then MAG modeling for the maintenance plan is conservative. In this case, peak concentrations measured at Valley monitors are likely to be less than forecasted in the CO Maintenance Plan.

The WSPA analysis also indicates that credit for RVP and oxygenated fuels may be overstated in MOBILE6. MAG modeling, using MOBILE6 for onroad mobile sources, indicates that CARB Phase 2 gasoline with 3.5 percent oxygenate in the winter provides the greatest benefit, by far, of any measure in the CO Maintenance Plan, a 21.5% reduction in 2015. Using the currently-approved version of MOBILE6, MAG can not demonstrate maintenance without this control measure. In future air quality plan revisions and conformity analyses, MAG will continue to use the CO emission factors and methodologies that are approved by EPA.

Comment: Footnote 1 on Figure ES-2 WSPA notes a footnote has been added to Figure ES-2 [2015 Carbon Monoxide Emission Reductions from Individual Maintenance Measures] which indicates that of the 21.5 percent reduction in emissions from the wintertime CARB Phase 2 with 3.5 percent oxygenate program, the majority (21.1) is due to the low sulfur content of the fuel. WSPA questions this footnote and would like to discuss this further with MAG.

Response: MAG would be happy to discuss this footnote with WSPA. Additional explanation is provided below.

The 21.5 percent reduction in carbon monoxide emissions from wintertime CARB Phase 2 with 3.5 percent oxygenate reflects the effects of changes in sulfur content, oxygenate content, and reid vapor pressure (RVP) relative to the properties of gasoline in the 1994 base case. This reduction also incorporates the effects of the gasoline formulation changes on both onroad and nonroad engines. The effects of the changes in gasoline formulation on onroad engines were calculated using the EPA MOBILE6 model, while the effects of the changes in formulation on nonroad engines were calculated using the CO Complex Model.

MAG modeling shows that 98 percent of the 21.5 percent reduction in CO emissions (or 21.1 percent) is attributable to the low sulfur content of the CARB Phase 2 with 3.5 percent oxygenate fuel. The effects of oxygenate and RVP are relatively small for the reasons described below.

The properties of gasoline in 1994 are very close to full oxygenate content (83 percent market share to ethanol at 3.5 percent by volume and 17 percent market share to MTBE at 2.5 percent by volume), while the CARB Phase 2 with 3.5 percent oxygenate assumes a 100 percent market share to ethanol at 3.5 percent by volume. Additionally, the MOBILE6 model applies lesser credit to oxygenated gasoline than the MOBILE5 model did. The vapor pressures assumed for the base case and CARB Phase 2 with 3.5 percent oxygenate are relatively close, with a base case RVP of 8.5 psi and a CARB Phase 2 RVP of 9.0 psi.

The 21.1 percent of the modeled reduction was determined to be attributable to the lower fuel sulfur content by performing MOBILE6 runs where the sulfur content was set to the levels for CARB Phase 2 with 3.5 percent oxygenate (i.e. 30 ppm), while the oxygenate and RVP were set to their 1994 base case values. (For comparison, in the modeled base case fuel formulation, the sulfur content was 120 ppm). The reduction in CO emissions due to use of low sulfur fuels in nonroad engines is negligible, because lower sulfur improves catalytic converter performance and the CO Maintenance Plan assumes that nonroad engines do not have catalytic converters in 2015.

<u>Comment:</u> <u>Variance Provision</u> Finally, WSPA notes that there is currently no variance provision in Arizona to deal with transportation fuel supply problems. We note that California has variance programs as part of its reformulated gasoline and diesel fuel regulations which allow for the production of "offspec" fuel during discrete periods of system disruption - such as during a refinery outage. WSPA is currently engaged in discussions with various agencies in Nevada in order to institute similar variance provisions in that state. We believe a variance provision should be a standard item in any SIP that contains fuel requirements, and would ask that MAG include language in the SIP to this effect, to be followed by appropriate regulatory revisions in concert with ADEQ.

<u>Response:</u> This comment will be forwarded to the Arizona Department of Environmental Quality and the Arizona Department of Weights and Measures for consideration. The State has control over fuel regulations.

**ADDENDUM TO
RESPONSE TO PUBLIC COMMENTS ON THE
DRAFT MAG CARBON MONOXIDE REDESIGNATION REQUEST AND
MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA**

COMMENTS FROM DIANNE BARKER (Received by e-mail from Ms. Barker, dated May 22, 2003)

Comment: The May 5, 2003 public hearing transcript is faulty. Page 11, lines 12-13 should be corrected to read: "I don't believe this will work after studying this plan."

Response: Thank you for the comment. It is so noted. Your e-mail will also be included with this response to comments.

Comment: There isn't any significant qualifying information gathered to date from MAG for EPA to lift the CO standard for this region and then expect our health is being protected.

Response: Over the years, several air quality measures have been implemented by the local governments and the State. As indicated in Figure ES-1 of the Carbon Monoxide Maintenance Plan, trends in carbon monoxide concentrations at the highest monitors in the Valley are continuing to decline. There have been no violations of the eight-hour carbon monoxide standard since 1996, despite a 25 percent increase in Maricopa County population. The Maintenance Plan indicates that the area will continue to attain the standard through 2015, ensuring that the 4.7 million people living in Maricopa County at that time, will continue to breathe air that has low levels of carbon monoxide.

Comment: Both the quality and the quantity of oxygenated fuels used is variable. MAG is unable to predict or demonstrate what verifiable proof there is to achieve proper control of consistent "cleaner burning" CARB Phase 2 and/or reformulated fuels per ARS 41-2122.23.24. The standard is neither met per state or federal law. "New motor vehicle emissions" will be, therefore, unavailable to change the CO redesignation status.

Response: Wintertime CARB Phase 2 fuel with 3.5 percent oxygenate is the most effective measure for reducing carbon monoxide emissions in the Carbon Monoxide Maintenance Plan. It reduces emissions by 21.5 percent when compared with fuels in 1994. Without this measure, the area can not show maintenance of the eight-hour standards through 2015. The Arizona Department of Environmental Quality has prepared the Clean Burning Gasoline Rules which contain the requirements for the program. In addition, the U.S. Environmental Protection Agency has adopted Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements (February 10, 2000) and Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements (January 18, 2001). According to EPA data, these new requirements will significantly reduce vehicle emissions further.

Comment: Moreover, at yesterday's meeting of the MAG's Transportation Planning Committee, a presenter shared information that we're acquiring the same number of cars as persons coming into Maricopa County, 100,000 this past year. Already we have 41,000 cars that we need to play "catch-up" for emissions testing. Surely, we're facing the real problem with acquiring many more cars in our region that it becomes difficult, perhaps impossible, to capture a tight pollution budget.

Response: Several air quality measures have been implemented in the region to reduce emissions from motor vehicles. In addition, the U.S. Environmental Protection Agency has adopted Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements (February 10, 2000) and Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements (January 18, 2001). According to EPA data, these new requirements will significantly reduce vehicle emissions further. The purpose of the Carbon Monoxide Maintenance Plan measure, Tougher Enforcement of Vehicle Registrations, is to reduce the number of vehicles that are not registering in Area A and as a result, are exempt from the Enhanced Vehicle Inspection Program. The Plan assumes that this measure will reduce carbon monoxide emissions by about 0.2 percent in 2015.

Comment: If we don't watch out where we are going, we can end up there. Maricopa County is one of the fastest growing counties in the United States and is a nonattainment area for particulates, ozone, and carbon monoxide pollutants. Surely, we can find verifiable solutions for our air quality problems from actualization of positive behavioral changes in usage of cleaner burning vehicles emitting less CO, multimodal use, trip reduction, telework etc.

Response: In accordance with the Clean Air Act, the Maricopa County nonattainment area is classified as a Serious Area for particulates, ozone, and carbon monoxide. A wide variety of air quality control measures have been implemented to reduce pollution throughout the region. Some of these measures include public transportation programs; regionwide travel reduction program; rideshare program incentives; bicycle and pedestrian travel; telework and teleconference. Many of these measures are listed as existing measures which are being strengthened in the Serious Area air quality plans.

COMMENTS FROM WILLIAM "BLUE" CROWLEY (Received from Mr. Crowley at MAG Management Committee meeting, dated May 14, 2003)

Comment: The job is not getting done; the largest contributor to carbon monoxide is the single occupant vehicle; the State and County should mandate that their employees take transit one day a week; at the Town Hall, participants said traffic synchronization is important; and lagging left is the best way to go.

Response: The Maricopa County Trip Reduction Program and the Regional Rideshare Program are important measures toward reducing single occupancy vehicle trips, and therefore tailpipe emissions, in Maricopa County. The Maricopa County Trip Reduction Program requires that employers with more than 50 employees develop and implement a Trip Reduction Plan to reduce single occupancy vehicle trips. Approximately $8.5 million in federal funding is programmed in the FY 2003-2007 MAG Transportation Improvement Program to fund transportation demand management programs in Maricopa County. Also, local funding is provided by the State for the Maricopa County Trip Reduction Program and Travel Reduction Program.

In addition, Maricopa County subsidizes 100 percent of the fare for public transportation for Maricopa County employees. The State of Arizona provides a 65 percent fare subsidy to State employees who use transit. Although no mandate is in place at this time for employees to take transit, employees may be encouraged through program incentives to carpool, telecommute, or use alternative modes of transportation.

Traffic signal synchronization is a committed measure in the Serious Area CO Plan and SB 1427, passed by the Arizona Legislature in 1998, requires cities and towns in Area A to "synchronize traffic control signals on all existing and new roadways, within and across jurisdictional boundaries, which a have a traffic flow exceeding 15,000 motor vehicles per day." Approximately $623 million is programmed in the FY 2003-2007 MAG Transportation Improvement Program for traffic flow improvements which includes traffic signal synchronization projects, and intersection improvements which may include lagging left signals.

COMMENTS FROM DIANNE BARKER (Received from Ms. Barker at MAG Regional Council meeting, dated May 28, 2003)

Comment: The Plan will not work because CARB Phase 2 fuel is a control measure. Western States Petroleum brings up a variance with fall supply problems. Control measures for fireplaces, ITS, and vehicle emissions account for less than one percent for each measure. People could make more of a difference if they would get out of their cars one day a week.

Response: Wintertime CARB Phase 2 fuel with 3.5 percent oxygenate is the most effective measure for reducing carbon monoxide emissions in the CO Maintenance Plan. It reduces emissions by 21.5 percent when compared with fuels in 1994. Without this measure, the area can not show maintenance of the eight-hour CO standard through 2015. Although the control measures "Clean Burning Fireplace Ordinance", "Develop Intelligent Transportation Systems", and "One Time Waiver from Vehicle Emissions Test" individually provide for less than one-half of one percent reduction in total emissions, cumulatively the measures demonstrate maintenance of the carbon monoxide standard through 2015. Finally, several programs are in place to encourage the reduction of single occupancy vehicle trips, including the Maricopa County Trip Reduction Program, the Regional Rideshare Program, and the State of Arizona's Travel Reduction Program.

COMMENTS FROM WILLIAM "BLUE" CROWLEY (Received from Mr. Crowley at MAG Regional Council meeting, dated May 28, 2003)

Comment: The Plan is cleaning the air, but poisoning the water. MTBE is not used in California any longer for this reason. Breathing is important, but so is water. The problem is the single occupant vehicle and suggested carpooling to meetings. It should be legislated that one day in five, employees from the state's largest employers (i.e., the State and City of Phoenix) make the sacrifice and use transit.

Response: CARB Phase 2 wintertime fuel does not include methyl-tertiary-butyl ether (MTBE). The only oxygenate used for wintertime fuel is ethanol. To address the second part of the question, the Maricopa County Trip Reduction Program and the Regional Rideshare Program are important measures toward reducing single occupancy vehicle trips, and therefore tailpipe emissions, in Maricopa County. The Maricopa County Trip Reduction Program requires that employers with more than 50 employees develop and implement a Trip Reduction Plan to reduce single occupancy vehicle trips. Approximately $8.5 million in federal funding is programmed in the FY 2003-2007 MAG Transportation Improvement Program to fund transportation demand management (TDM) programs in Maricopa County. Also, local funding is provided by the State for some TDM programs.

In addition, Maricopa County subsidizes the cost of public transportation to Maricopa County employees at 100 percent. In addition, the State of Arizona provides a 65 percent subsidy to State employees who use transit. Although no mandate is in place at this time for employees to take transit, employees may be encouraged to carpool, telecommute, or use alternative modes of transportation through program incentives.

Lindy Bauer

From: Tax.Wienke@epamail.epa.gov
Sent: Monday, May 05, 2003 11:41 AM
To: lbauer@mag.maricopa.gov
Cc: McKaughan.Colleen@epamail.epa.gov; Bohning.Scott@epamail.epa.gov; pella.theresa@ev.state.az.us; toopal.mohan@ev.state.az.us; jcrumbaker@mail.maricopa.gov; speplau@mail.maricopa.gov
Subject: Comments on Draft CO Maintenance Plan

Hello Lindy -

Thank you for the opportunity to review and comment on the draft MAG CO redesignation and maintenance plan. We are favorably impressed with MAG's efforts in streamlining the plan. We also want to thank you for your attention responding thoroughly to the comments on the previous draft, for your attention to correcting the conformity budget issues we raised on the previous draft, and for providing an electronic copy of the plan when you submit it to us. As you know, the electronic copy will facilitate our process of determining the adequacy of the budgets in the plan.

Our attorney Jeff Wehling, felt the trigger for the contingency measures is not protective enough. Our understanding is that only two monitored CO concentrations of 9.5 or more at any one station in a calendar year would be considered a NAAQS violation, and thus, the proposed triggering scenario would not be sufficient to satisfy section 175A(d) of the Act. The contingency measures portion of the plan should be modified to reflect this comment.

The maintenance plan states that 21.1 of 21.5% of the reduction from the oxygenated fuels program between 2000 and 2015 comes from low sulfur content. This leaves only 0.4% reductions in that period from RVP and oxygenate. Is the statement that 21.1% of the reductions come from low sulfur content correct? How was this number derived?

The measure "Defer emissions associated with government activities" is generally characterized as a measure for which no credit was taken. However, the response to comments states that "a 6% decrease in emissions was shifted". If we understand correctly that a decrease in one time period was balanced with an increase in another time period in the modeling, it would be clearer to say "6% of the emissions were shifted".

On the periodic inventories on page 2-23, it would be nice if you would list a start year and milestone years for the periodic inventories.

Please do not hesitate to contact me if you have questions or want to discuss any of these. I can be reached at 520/622-1622 or tax.wienke@epa.gov.

Sincerely,

Wienke Tax

Wienke Tax
USEPA Region 9
P.O. Box 86825
Tucson, AZ 85754-6825
Phone/Fax: 520.622.1622

WSPA
Western States Petroleum Association
Credible Solutions • Responsive Service • Since 1907

Gina Grey, Manager May 5, 2003

Ms. Lindy Bauer, Manager
Maricopa Association of Governments
302 1st Ave., Suite 300
Phoenix, AZ 85003

Re. Carbon Monoxide Maintenance Plan and CO Redesignation Request for Maricopa County Nonattainment Area – WSPA Comments

Dear Lindy:

The Western States Petroleum Association (WSPA) would like to provide comments on the draft CO Maintenance Plan that is currently under review at MAG. As you know, WSPA is a non profit trade organization that represents over 30 natural gas and petroleum exploration, production, refining, transportation and marketing companies operating in six western states. Since our companies produce the fuels that are nominated in the Maintenance Plan to continue to carry the major share of responsibility for keeping CO levels below the standard, we obviously have a significant interest in the Plan.

Redesignation Request
First, WSPA would like to support MAG and the state in the Area A CO redesignation request to EPA. Similar to many other major population centers across the U.S., the air pollutant monitor data is clear that over the past several years the region has been able to attain the standard and sustain lower CO levels in the face of tremendous growth in population and VMT.

Mobile 6 Problems
Second, in terms of the CO Maintenance Plan, you have, over the past six months, been made aware of WSPA's concerns relative to the science being used in the Plan, and have reviewed the work that Sierra Research has completed for us. In the fall of 2002, Sierra Research raised concerns to Region 10 about the representativeness of projected carbon monoxide (CO) emission rates calculated by MOBILE6. Those concerns were related to assumptions about the effects of

technology on CO rates in cold temperature climates and were based on analysis prepared for the Alaska Department of Environmental Conservation (ADEC).

During the same time period, additional CO-related assessments of other western nonattainment areas were being conducted by Sierra for WSPA. Based on these efforts, we have come to the conclusion that MOBILE6 forecasts of CO emission rates are seriously flawed. Moreover, we find that flaws in these forecasts are adversely impacting decisions about the need for control strategies in both cold-temperature and warm-weather CO nonattainment areas.

A number of studies published over the last year have raised concerns that MOBILE6 is over-predicting CO emissions from on-road motor vehicles. For example, a comparison of ambient CO trends versus MOBILE6 inventory trends conducted by Sierra has shown that ambient CO concentrations in many western communities dropped significantly between 1996 and 2001, while the trend in on-road motor vehicle CO emissions calculated with MOBILE6 is relatively flat during this time period. Environ Corporation compared CO emission rates based on tunnel studies to MOBILE6 predictions and found that the MOBILE6 results are "much higher" than the observed values for the Ft. McHenry, MD and Tuscarora Mountain, PA tunnel studies. Desert Research Institute compared remote sensing data collected in Clark County, Nevada, to MOBILE6 CO estimates and found that "the most important discrepancy" was for CO emissions from LDGVs, with MOBILE6 estimates being twice those of the on-road tests, suggesting "further examination of the model… is warranted." Finally, an evaluation of California's EMFAC2002 model prepared by Sierra has shown much lower light-duty vehicle CO emissions in absolute terms and a much steeper decline between 2000 and 2010 than predicted by MOBILE6.

No fewer than five separate communities in the west are considering revisions to their CO SIPs. Their choice of control measures is being restricted by conservative (i.e., inflated) CO emission rate projections incorporated into MOBILE6. As a result, communities are reluctant to eliminate existing control programs, even if they are no longer cost-effective. The communities currently considering SIP revisions include Anchorage, Fairbanks, Phoenix, Las Vegas, and Spokane.

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The large increase in projected CO rates combined with the large reductions predicted by MOBILE6 for wintertime RVP control ensures the continuance of these programs even when available data indicate that the benefits of these controls are marginal (this is an issue in Las Vegas and Phoenix). Similarly, the large increase in projected CO emission rates combined with rapidly declining but still substantial benefits of oxygenated fuels ensures the continuance of these programs (this is an issue in Spokane, Anchorage, Las Vegas, and Phoenix). Even more troubling is the fact that some communities are considering the adoption of additional controls to offset (a) the increase in projected CO rates and (b) conservative assumptions about the collateral benefits of technologies introduced to meet Tier 2 standards (this is an issue in Fairbanks and Spokane). Additional areas impacted by these concerns are those with existing maintenance plan control measure commitments and include Tucson, Reno, and Portland. Based on these findings, we are, and will continue, to urge EPA to prepare revisions to MOBILE6 CO emission rate projections and to develop and release a modified version of the model.

Presented below is a brief summary of model assumptions and inputs that should be considered for revision:

- Projected improvements in MOBILE6 CO rates are based on the ratio of future to current emission standards. Since many NLEV and Tier 2 vehicles have a CO certification standard equivalent to the Tier 1 CO standard of 3.4 g/mi, forecasts of CO emission rates do not account for concomitant reductions that will occur from the technology needed to meet the very stringent hydrocarbon standards required of NLEV and Tier 2 vehicles.

- The cold-temperature (i.e., below 75F) exhaust RVP correction factors used in MOBILE6 were developed for 1983 and newer model year vehicles and have not been revised since MOBILE4 was released in 1989. Since those exhaust RVP factors were developed, there have been significant changes in vehicle design that have dramatically reduced or eliminated the cause of RVP/exhaust interactions (i.e., much better fuel control and evaporative canister purge strategies leading to stoichiometric operation under nearly all operating conditions). Additional concerns include: (a) it appears that the analysis upon which the MOBILE4 factors are based failed to account for important differences in fuel properties such as sulfur content; (b) the exhaust RVP correction factors for temperatures below 75F are not based on actual emissions data but rather on extrapolations on the 75F estimates; and (c) RVP exhaust correction factors appear to be incorrectly applied to start emissions in MOBILE6.

- MOBILE6 assumptions about sulfur sensitivity appear to vary by certification category. As a result, CO rates from Tier 1 vehicles are projected by MOBILE6 to be lower than either NLEV or Tier 2 - Bin 5 vehicles, assuming that Tier 2 sulfur requirements have been fully phased-in.

In summary, the issues outlined above raise legitimate concerns about the accuracy of projected CO emission rates in MOBILE6. While originally raised within the context of Alaska CO maintenance planning, the more recent Sierra Research work for WSPA shows that conservative assumptions about the collateral benefits of Tier 2 technology improvements are an issue for many western CO nonattainment and maintenance areas. That work also showed that problems with the benefits of wintertime RVP controls further complicate CO planning efforts.

WSPA believes a revised version of MOBILE^ reflecting the corrections discussed above would not jeopardize MAG's current efforts to demonstrate conformity or attainment of the CO NAAQS. We would like to have MAG's support, and ADEQ's for that matter, in advocating with the EPA that MOBILE6 needs to be fixed expeditiously. Alternatively, EPA needs to offer areas like Phoenix an approach to CO SIP development that does not rely strictly on rigorous application of MOBILE6 in its present form.

Footnote 1 on Figure ES-2

WSPA notes a footnote has been added to Figure ES-2 [2015 Carbon Monoxide Emission Reductions from Individual Maintenance Measures] which indicates that of the 21.5 percent reduction in emissions from the wintertime CARB Phase 2 with 3.5% oxygenate program, the majority (21.1%) is due to the low sulfur content of the fuel. WSPA questions this footnote and would like to discuss this further with MAG.

Variance Provision

Finally, WSPA notes that there is currently no variance provision in Arizona to deal with transportation fuel supply problems. We note that California has variance programs as part of its reformulated gasoline and diesel fuel regulations which allow for the production of "offspec" fuel during discrete periods of system disruption – such as during a refinery outage. WSPA is currently engaged in discussions with various agencies in Nevada in order to institute similar variance provisions in that state. We believe a variance provision should be a standard item in any SIP that contains fuel requirements, and would ask that MAG include language in the SIP to this effect, to be followed by appropriate regulatory revisions in concert with ADEQ.

WSPA appreciates the opportunity to provide comments on the redesignation request and CO Maintenance Plan. If you have any questions, please do not hesitate to call me.

Sincerely,

Gina Grey

Gina D. Grey

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Lindy Bauer

From:	Dianne Barker DD [dteam10@yahoo.com]
Sent:	Thursday, May 22, 2003 8:48 PM
To:	lbauer@mag.maricopa.gov
Subject:	Public Hearing & Transcript Correction

May 22, 2003

Ms. Lindy Bauer, Environmental Manager
Maricopa Association of Governments
302 N. 1st Avenue, Suite #300
Phoenix, Arizona 85003

Dear Ms. Bauer:

Per our discussion and your suggestion, Lindy, I'm requesting correction of MAG's May 5, 2003, faulty "CO" public hearing transcript as follows:

Page 11, Lines 12-13

"I don't believe this will work after studing this plan,"

Furthermore, please accept my reply to MAG's response(s) to the hearing. I'm sorry that upon thorough review that I find there isn't any significant qualifying information gathered to date from MAG for EPA to lift the CO standard for this region. We must protect our health.

Both the quality and the quantity of oxgenated fuels used by this is a variable. MAG is unable to predict nor demonstrate what verifiable proof there is to achieve proper control of consistant "cleaner burning",
CARB PHASE 2 and/or reformulated fuels per ARS 41-2122.23.24. The standard
is niether met per state or federal law. "New moter vehicle emissions" will be, therefore, unavailable to a change CO redesigation status.

Moreover, at yesterday's meeting of MAG's Transporation Planning Committee,"TPC", a presenter shared information that we're aquiring the same number of cars as persons coming into Maricopa County , 100,000 past
annual year. Already we have 41,000 cars that we need to play "catch-up" for emissions testing. Surely we're facing the real problem with acquiring many more cars in our region that it becomes difficult, perhaps
impossible, to capture a tight pollution budget.

Finally, if we don't watch out were we're going, we can end up there.

Maricopa County is one of the fastest growing counties in the United States and is a non-attainment area for particulates, ozone and carbon monoxide pollutants. Surely we can find verifiable solutions for our air quality problems from actualization of positive behavorial changes in usage of cleaner buring vehicles emitting less CO, multimodal use, trip *reduction, telework, etc, Lindy.*

Thank you for your correction and attention.

Sincerely,

DD Barker

c: Governmental Officials
   Citizens
   Friends

=====
D TEAM DIVERSIFIED
P.O. BOX 32275
Phoenix, AZ 85064-2275
(602) 999-4448

DD Barker, President

APPENDIX B

EXHIBIT 2

Certification of Adoption

RESOLUTION TO ADOPT THE MAG CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

WHEREAS, the Maricopa Association of Governments (MAG) is a Council of Governments composed of twenty-five cities and towns within Maricopa County and the contiguous urbanized area, the County of Maricopa, the Gila River Indian Community, the Salt River Pima-Maricopa Indian Community, Arizona Department of Transportation, and Citizens Transportation Oversight Committee; and

WHEREAS, the Governor of Arizona designated MAG as the regional air quality planning agency and metropolitan planning organization for transportation in Maricopa County; and

WHEREAS, the Maricopa County nonattainment area has been classified by the U.S. Environmental Protection Agency as a Serious Area for carbon monoxide according to the Clean Air Act; and

WHEREAS, the Maricopa County nonattainment area has had no violations of the carbon monoxide standards since 1996; and

WHEREAS, MAG has prepared the Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area, including the modeling maintenance demonstration; and

WHEREAS, A.R.S. 49-406 H. requires that the governing body of the metropolitan planning organization adopt the maintenance area plan.

NOW THEREFORE, BE IT RESOLVED BY THE MARICOPA ASSOCIATION OF GOVERNMENTS REGIONAL COUNCIL as follows:

SECTION 1. That the MAG Regional Council adopts the MAG Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area and authorizes the submission of the plan to the Arizona Department of Environmental Quality and the U.S. Environmental Protection Agency.

SECTION 2. That the MAG Regional Council further requests that the U.S. Environmental Protection Agency redesignate the Maricopa County nonattainment area to attainment status for carbon monoxide.

ADOPTED the twenty-eighth day of May 2003 by the MAG Regional Council.

Wendy Feldman-Kerr
Chairman, MAG Regional Council
Mayor of Queen Creek

ATTEST:

Dennis W. Smith, Executive Director
Maricopa Association of Governments

CERTIFICATION OF ADOPTION OF THE MAG CARBON MONOXIDE REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE MARICOPA COUNTY NONATTAINMENT AREA

An Excerpt from the May 28, 2003 MAG Regional Council Meeting Minutes

Mayor Edward Lowry moved to adopt the MAG Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area. Mayor Steven Berman seconded, and the motion carried unanimously.

I certify that on May 28, 2003, the MAG Regional Council adopted the MAG Carbon Monoxide Redesignation Request and Maintenance Plan for the Maricopa County Nonattainment Area.

Dennis W. Smith
MAG Executive Director

May 29, 2003
Date